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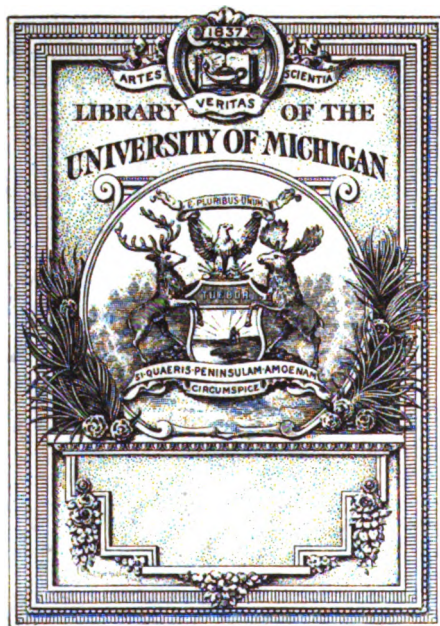
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# *Archives of otology*



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# ARCHIVES OF OTOLOGY

*EDITED IN ENGLISH AND GERMAN*

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VOLUME XIV.

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## ARCHIVES OF OTOTOLOGY.

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### ON THE SIGNIFICANCE OF THE DEVELOPMENT OF OPTIC NEURITIS IN CASES OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

By CHARLES J. KIPP.

**D**URING the five years that have passed since I published in THESE ARCHIVES (vol. viii., p. 147) four cases of purulent inflammation of the middle ear in which optic neuritis was present, I have made frequent examinations of the eyes in nearly all cases of suppuration of the middle ear that have been under my care.

Briefly summarized the results obtained were as follows.

Optic neuritis was found in only a very small proportion of all the cases examined. In the majority of cases with optic neuritis well-marked symptoms of meningitis or abscess of the brain, such as fever, persistent and severe headache, vomiting, delirium, drowsiness, stupor, convulsions, hemiplegia, or paralysis of ocular muscles, were present either at the time the optic neuritis first showed itself or came on soon afterward.

In a few cases persistent headache and occasional nausea or vomiting were the only symptoms pointing to a cerebral complication present during the whole course of the ear affection.

Optic neuritis was observed only in cases of otorrhœa of long standing.

In some there was manifest disease of the mastoid cells, but in most cases the mastoid region was neither red, swollen, nor tender on pressure. More or less swelling of the wall of the external canal, perforation of the drum membrane, polypoid granulations, and swelling of the lining membrane of the tympanic cavity were present in all.

Caries of the external canal and of the tympanic cavity could be discovered in many of the cases.

The patients were nearly all adults.

A fatal termination occurred in somewhat more than half of the cases. Most of these came under my observation only a short time before death occurred, and in only one was the mastoid process opened. In this instance the mastoid process was found sclerosed, and no pus was evacuated.

In the remaining cases the patients gradually recovered their health, and in all no marked impairment of sight remained, although the optic papillæ were somewhat blanched. With regard to the cerebral symptoms present in these cases, it must be said that they were not very pronounced in all. In some only severe and persistent headache, vertigo, restlessness, and nausea or vomiting were present, but in others there were in addition high fever, delirium, drowsiness, stupor, convulsions, or paralysis of some of the external muscles of the eye. Hemiplegia or general paralysis occurred, however, in none of these cases. Caries and necrosis of the outer wall of the mastoid process existed in most of the cases that recovered. In one case the optic neuritis was not developed till a spontaneous perforation of the outer cortex had taken place on both sides. In the cases without disease of the external part of the mastoid, no opening was made in this process. Facial paralysis was absent in all of the cases of recovery.

If we now inquire in what proportion of the cases ending in death with symptoms of meningitis or cerebral abscess, the optic neuritis was absent, we find that in fully one half of the fatal cases no optic neuritis was developed while they were under my observation. If we include the cases of death from supposed phlebitis and thrombosis of the lateral and the petrosal sinuses this proportion is of course still smaller. (I may state here that I do not remember ever to have seen optic neuritis in cases of pure phlebitis and thrombosis.) In a considerable number of the fatal cases without optic neuritis I was able to continue the examination of the eyes till shortly before death, but some did not see during the last four weeks of their life, and I cannot therefore posi-

tively say that no optic neuritis was developed after the patients passed out of my hands. My information of the fatal termination of these cases was obtained from the physicians in attendance or from the patients' friends. Unfortunately I was unable to make the autopsy in most of the cases that died without having had optic neuritis. In those in which an autopsy was permitted, the clinical diagnosis of meningitis of the base and of abscess of the brain was confirmed by the anatomical examination. Caries of the roof of the tympanic cavity, of the roof of the mastoid antrum, or of some portion of the inner surface of the temporal bone was present in all of these cases except one, and in this instance a discoloration of the inner surface of the tegmen tympani was seen after the preparation had been macerated.

From the above statement it will be seen: first, that optic neuritis is by no means a constant symptom of otitic meningitis or cerebral abscess, and secondly, that the intracranial disease connected with the optic neuritis does not always terminate in death. That the optic neuritis was caused in all of these cases by an inflammation of the cerebral meninges or of the brain itself I am, of course, unable to prove. I think it, however, very probable. Purulent meningitis of the base was found in all the cases with optic neuritis in which an autopsy was made, and it seems, therefore, only fair to assume that it existed also in the cases in which the other symptoms of meningitis were less pronounced and which recovered. Whether in the cases of recovery the inflammation of the inner membranes was not associated with caries and perforation of the dura mater, or if caries was present, only the outer surface of the dura mater was inflamed, as Politzer suggests,<sup>1</sup> or whether simple hyperæmia of the meninges may be sufficient to produce all the symptoms, including the optic neuritis, as Alt<sup>2</sup> seems to think, can only be determined by further observation. But whatever the actual condition of the meninges or of the brain substance that gives rise to the optic neuritis may be at the time when this first shows itself, it is

<sup>1</sup> "Lehrbuch der Ohrenheilkunde," p. 604.

<sup>2</sup> "Transactions of the American Otological Society," 1884, p. 236.

quite certain, as we have seen, that it only too often terminates in purulent pachymeningitis and leptomeningitis, and abscess of the brain.

As a rule, the development of optic neuritis in connection with otorrhœa should, therefore, I think, be looked upon as evidence that an intracranial complication has set in or is impending. At the same time the fact should not be lost sight of, that optic neuritis is occasionally developed in persons, more particularly children, free from ear disease and apparently in excellent health, and that therefore, a primary optic neuritis may also occur in individuals with purulent inflammation of the middle ear. Coincidences of this kind are, however, extremely rare. To discriminate a primary optic neuritis from a consecutive one by the appearances of the eye is not possible, and it will, therefore, be safe to regard the eye trouble as a primary disease only when all signs of cerebral irritation are absent. To avoid errors of diagnosis it is also necessary that the examination of the eyes should be begun in the earliest stages of the ear disease, as otherwise we cannot be sure that the optic neuritis did not precede the attack of the ear disease. Only recently a case occurred in my practice which illustrates the importance of an early examination. A well-developed and apparently healthy boy, five years old, in whom I had by mere accident, some weeks before, discovered a well-marked optic neuritis of both eyes, without impairment of sight, was suddenly attacked by great pain in his left ear, high fever, vomiting, intense headaches, and mild delirium. Some days later a perforation of the membrana tympani occurred, with a free discharge. Six weeks later the perforation closed and since then the boy has been well, although he still complains occasionally of headaches. Now, if I had not known the condition of this boy's eyes, or if I had delayed the examination of the eyes till his condition became alarming, I should certainly have attributed the optic neuritis to some cerebral trouble caused by the ear disease. In this connection I would also remind the reader that scarlet-fever and measles, the very diseases that cause most of the cases of middle-ear suppuration, do also occasionally cause

optic neuritis. In these cases the optic neuritis is probably the result of a meningitis, although the symptoms are by no means always pronounced. It should also be borne in mind that tubercular meningitis may supervene on aural disease, and that the optic neuritis may be due to this disease.

With regard to the ophthalmoscopic appearances observed in my cases I need only say, that they differed in no wise from those of the ordinary form of optic neuritis of moderate degree. The swelling of the optic papilla, although never very great, was always distinctly visible during the height of the disease. The color of the papilla was either reddish or reddish-gray, and the edge of the papilla was either blurred or completely hidden. The adjacent retina was more or less opaque and it, as well as the peripheric portions of the papilla, was distinctly striated. The retinal veins were always fuller than normal. Hemorrhages and white plaques on the disk or in the retina were seen in only a few cases. The more intense form of optic neuritis known as choked disk, which occurs in connection with tumors of the brain, I have never seen in cases of otorrhœa. In all except one of my cases the optic neuritis was present in both eyes.

From what has preceded it must be obvious that the presence of optic neuritis does not afford us great help in forming a plan of treatment in all cases. We have seen that cases occasionally recover in which no artificial opening was made in the mastoid, and that in others speedy recovery followed such an opening. On the whole, I believe, however, that it would be best to open the mastoid in every case in which we are reasonably certain that the cerebral disease is due to caries, or to the retention of decaying pus in the mastoid antrum or the mastoid cells. It is needless to say, that the optic neuritis requires no special treatment.



# OBSERVATIONS ON THE USE OF THE PEROXIDE OF HYDROGEN IN SUPPURATING EARS, ETC.

By WILLIAM A. DAYTON, M.D.,

SURGEON TO THE EYE, EAR, AND THROAT DEP'T, HARLEM DISPENSARY; ASSIST'T TO DR. ROOSA'S CLINIC, MANHATTAN EYE AND EAR HOSPITAL, ETC., NEW YORK.

FOR some reason the use of the peroxide of hydrogen in suppurative otitis media is not well known. Indeed, so scanty is the literature on the subject that the existence of such a combination as  $\text{HO}_2$  had been forgotten by the writer, together with other formulæ, since the last examination on chemistry.

## *As to the History of the Peroxide or Deutoxide of Hydrogen.*

This singular fluid was discovered by M. Thénard in 1818. It was found to bleach organic substances, and was used to restore the blackened lights of paintings which had become darkened from the lead they contain. It was also proposed by M. de Sondala as a means of supplying oxygen to diving-bells and other confined places.

As manufactured (and I understand that it is manufactured exclusively abroad), it is a colorless, limpid fluid (containing 12 %, by volume, of the gas in instilled water), having an acid reaction, metallic taste, and is stable at a low temperature, *but resolves into oxygen and water at 59° F.* It mixes with water in *all* proportions, and becomes more permanent when so diluted.

The use of the fluid in ophthalmic practice has doubtless been made familiar through the writings of Landolt *et al.*,

but a pamphlet by Julius Hensel, of Stuttgart, entitled "Neue Makrobiotic, oder die Kunst Seuchen zu verhüten und zu heilen," and published in 1881, presents a most interesting account of the local as well as the constitutional effects of this agent.

To illustrate its action, Hensel says: If a decomposed egg be mixed with a drachm of a ten- or a twelve-per-cent. solution of the hydrogen peroxide, a somewhat active effervescence occurs, a scum rises to the surface, and the odor of sulphuretted hydrogen disappears, leaving an odor which he compares to that of roasted meat. Again, milk, when mixed in equal proportions with this same solution, can be kept for years without changing.

Its action appears to be confined to decomposed albuminous matters, as blood-albumen and egg-albumen in a fresh state are not perceptibly affected by it.

Hensel, from the standpoint of a chemist, agrees with Dr. Richardson and a few other observers that the peroxide, in weak solutions, must be a valuable remedy in phthisis, as well as in the diseases of all mucous membranes.

My first experience with the peroxide in suppurative otitis media dates from November 3, 1884, when I was induced to try it in the case of a girl, æt. thirteen, who was about to abandon all treatment in hopeless despair. History of the case incomplete. Suppuration probably began in infancy, following an attack of measles. In spite of repeated removals of large granulations, which filled both tympanic cavities alike—in spite of astringents, boric acid, and thorough cleansing,—the discharge of fetid pus continued and the granulations re-appeared.

I do not think that the ossicles were swept away, but there was so much thickening at their site that it was, and is now, impossible to tell.

On November 3d, after the instillation of a four-per-cent. solution of cocaine muriate, with a Buck's curette I scraped out of the right tympanic cavity all the granulations as before. Without syringing the canal, and merely wiping out with cotton a part of the blood that filled it, I poured in about ten drops of a twelve-per-cent. solution of hydrogen peroxide. Immediately an effervescence occurred; the red color of the blood disappeared, a

scum foamed over the concha, and the usual sickening odor was wanting. After drying there was still some cheesy-looking material (pus?) in the canal, which a second application of the peroxide removed. On drying again, I found that the hemorrhage had ceased; the parts were cleaner than they had ever been; the patient considered the operation and the applications alike absolutely painless, and insisted that she "heard things clearer."

Both this patient and myself were so much gratified, that I repeated the same procedures in the left ear, with similar effect.

For two weeks a twelve-per-cent. solution of the peroxide (ten or twelve drops) was instilled into each ear, morning and night. Syringing was omitted. Two weeks later there were indications that the granulations were re-forming; these were touched (once) with a four-per-cent. solution of nitrate of silver, and a five-per-cent. solution of hydrogen peroxide was employed twice daily until the sixth week, when the discharge ceased.

The hearing distance for the watch at the commencement of the treatment was: H. D. R =  $\frac{1}{8}$ ; H. D. L =  $\frac{1}{16}$ ; C tuning-fork heard better through the bone. Since January 2d, by inflation, hearing distance for the watch gradually brought to: H. D. R =  $\frac{1}{16}$ ; H. D. L =  $\frac{1}{8}$ . Bone-conduction of tuning-fork C, of course, better.

In three cases of acute suppuration of the middle ear, treated at my clinic at the Harlem Dispensary with a ten-per-cent. solution of the peroxide and gentle inflation, the drumheads healed at the end of a week.

About the middle of December last I introduced the use of the peroxide at Dr. Roosa's clinic in the Manhattan Eye and Ear Hospital. The three cases in which it was first tried had all been under observation for purulent otitis media for eighteen months and upward. Within a week marked improvement occurred.

One of these patients complained of "a pounding noise in the ear which kept him awake night after night," and which the bromides failed of relieving. After the third application of the peroxide of hydrogen the discharge from the ear became limpid and inconsiderable, and the "pounding noise" stopped. Out of thirty-four cases of suppurative inflammation of the middle ear treated by peroxide of hydrogen during the past eleven weeks, the discharge has

stopped in nine, and the hearing distance has been improved in all that remained under observation.

In several instances I found that, while the character of the discharge was altered, it did not cease; so that, in addition to the use of the hydrogen, I packed the external auditory canal, after careful drying, with boric acid every other day.

Why it is that some ulcerating surfaces heal without being protected from the air, I do not pretend to say; but certain it is that there are cases in which such protection is required, and I know of no better plan than that of packing the external auditory canal with finely powdered boric acid.

As Dr. Roosa teaches, "it is often necessary for the physician to see cases of suppuration daily for the proper cleansing of the ears"; and I add with emphasis that the most gratifying results from the use of the peroxide have followed when I could superintend, personally, the necessary applications.

More than two applications daily will rarely be required; but surely no fixed rules can well be expressed or adopted in view of the vast disparity which exists in ever-varying pathological conditions. Again, I do not think it always best to use a twelve-per-cent. solution of hydrogen peroxide in suppurative otitis; in children and neurotic subjects the lively effervescence caused by the strong *acid* solution ( $\text{HO}_2$ ) with the alkaline discharge, occasions complaint; and I have seen a strong man swoon during the first application. Indeed,\* I am inclined to believe that the better plan, in certain cases, is to begin with a six-per-cent. solution, and gradually increase it to twelve per cent. Leading otologists differ as to the relative merits of "the wet" and "the dry" treatment of suppurating ears. It is well known, however, that the use of the syringe, frequently, lights up old suppurations; and, occasionally, patients observe that the discharge decreases when their ears are not syringed. Now, it is in just such cases that the value of the peroxide of hydrogen is demonstrated. I do not know of a single instance, in which its use augmented the discharge. Moreover, I believe it will hasten the process of repair, which syringing often prevents.

The internal administration of a two-per-cent. solution of the peroxide I have tried in table-spoonful doses, with growing confidence in its efficacy.

Dr. B. W. Richardson of London, as well as Mr. Hensel of Germany, has written confidently of its internal use in catarrhal affections of the stomach, intestines, *air passages*, etc., and I am now using a two-per-cent. solution in table-spoonful doses in several abandoned cases of middle-ear catarrh. The slight improvement in the hearing distance of these patients may be a mere coincidence, but I intend to continue the internal administration of the peroxide, in the belief that it may prove a valuable remedy.

By far the larger number of our ear patients are sufferers from naso-pharyngeal catarrh; nor should this be overlooked in the treatment. In fact, I have been as particular in my attention to the nose and throat as to the ear itself.

A spray of a four-per-cent. solution of the peroxide has had an almost magical effect in a case of ozæna complicated with "proliferous" catarrh of the middle ears. It will be observed that the stronger solutions induce local anæsthesia often in a marked degree. This is certainly advantageous, not only in the event of operative interference, but also in doing rhinoscopic work; besides, I have noticed that cocaine acted more promptly after the mucous membrane had been cleansed with the peroxide.

The above is but a hint at the various applications of this agent, should it meet the expectations of interested workers.

Even though no curative results are obtained in the experience of others from the peroxide *per se*, it *will* be found to be a most marvellous cleanser; and, if cleanliness is *the* desideratum in middle-ear suppuration, then we have a servant *par excellence* in the peroxide of hydrogen.

January 23, 1885.

## CLINICAL CONTRIBUTIONS TO OTOTOLOGY (THREE CASES).

By W. CHEATHAM, M.D., LOUISVILLE, Ky.

### A case of atresia of auditory canal.

Mary B., German, age twenty. Had in her early life otit. med. suppurativa. Has had no discharge from middle ears for ten years. She came to me stating "her ears were closing up." I found her auditory canal so small as to scarcely admit a Bowman probe No. 1. I could discover no evidence of increase in either the bone or the cartilage of canal. She had no pain, nor any other evidence of inflammation. Appeared to me to be pure hypertrophy of skin of ext. aud. canal. I tried dilators, tents, and incision with no result. The process continued until the canals were entirely closed. They have now been in this condition for one year, with no discomfort, except increase of deafness, with occasional vertigo.

### A case of exceedingly small auditory canals. .

Annie T., age eleven. Came to me complaining of deafness, that had existed for ten days ; hearing good up to that time. Deafness occurred suddenly. No earache. No catarrh. Mother always found difficulty in getting wash rag into ear. Canal always as small as now ; find difficulty in introducing Bowman No. 2. Found this small canal plugged with wax. Hearing distance, each,  $\frac{1}{2}$  ft. Removed plug of wax, and hearing distance increased to  $\frac{1}{2}$  ft. After four months her hearing is the same.

### A case of a secondary drum membrane.

Mary R., age fifty, domestic. Reported, complaining of stoppage of ears. Found both auditory canals closed by membranes at external orifice. Membranes appeared to be true skin, not cicatricial tissue. Quite elastic. Apparently plenty of space behind. Gives

history of chronic suppuration years ago. Back of right ear has appearances of previous severe mastoid disease. Says a large bone came from that region some time ago. Bone-conduction is good in left ear, absent in right.

A peculiar part of the case is that she can hear common conversation six feet with her left ear. She can, of course, hear nothing in right ear. She was quite anxious to have me remove the membrane. Believing the normal drum to have been swept away in her attack of otit. med. suppur., and that this membrane was taking its place, I explained its effect to her. She kindly consented to allow it to remain.

A CASE OF ACUTE INFLAMMATION OF THE MIDDLE  
AND INTERNAL EARS (PANOTITIS), FOLLOWED  
BY FACIAL PARALYSIS AND NECROSIS AND RE-  
MOVAL OF THE WHOLE PETROUS PORTION OF  
THE TEMPORAL BONE, WITH THE ANNULUS  
TYMPANICUS—RECOVERY.

By D. B. ST. JOHN ROOSA, M.D., AND J. B. EMERSON, M.D.

*(With four wood-cuts.)*

H. G., four years of age, female, was sent to Dr. Roosa February 1, 1884, by Dr. S. G. Carpenter, of Chester, N. Y., who furnished the following history :

"On June 25, 1883, the patient was attacked with scarlet-fever ; eruption was copious ; temperature,  $105^{\circ}$  ; eruption began to decline on the sixth day. The throat was affected early ; the tonsils, uvula, and pharynx were covered with a dense diphtheritic membrane on the second day ; the nares were also affected, and discharged an irritating mucus. Soon after the ears began discharging. Her general condition was one of coma, from which she could be partially aroused by the handling necessary to cleanse the throat and nares. At the time that the eruption began declining, sloughing occurred in both tonsils. On the tenth day facial paralysis was first noticed on the left side. A little later a puffy swelling made its appearance over the mastoid, which eventually suppurated. There was complete deafness for a time, but later the hearing of the right ear became partially restored."

Her condition when first seen at the office was as follows : There was complete left facial paralysis ; discharge from both ears, that from the left being very fetid and profuse ; there was a fistula in the mastoid leading down to rough bone ; granulations in both tympanic cavities. The general condition was good.



*February 2d.*—Dr. Roosa made an incision, under ether, through the skin and periosteum of the left mastoid, enlarged the existing sinus in the mastoid cells with a drill, and removed the granulations from the tympanum with a sharp curette. The mastoid cells and ear were washed out with a weak solution of chlorinated soda, and a tent inserted in the wound.

*February 3d.*—The edges of the wound looking red and infiltrated, a poultice was ordered.

*February 7th.*—Poultice discontinued ; wound looks healthy ; a free, fetid discharge from both canal and mastoid opening.

*March 12th.*—The wound has been cleansed daily with a weak solution of chlorinated soda, and the granulations removed as they sprung up. The discharge has entirely ceased from the right ear, but continues profuse from the left ear.

*March 13th.*—The opening in the mastoid was enlarged, under ether, and small particles of dead bone scraped off by Dr. Roosa.

*March 14th.*—There is now an opening down into the mastoid cells about the size of the end of a little finger. In dressing the wound a small fragment of bone about the size of a three-cent piece came away. The patient soon after this was placed in the Manhattan Eye and Ear Hospital, and from this time the notes were made by Drs. Beard and Hale, House Surgeons.

*March 29th.*—Considerable swelling about mastoid ; the auricle was pushed forward. A great deal of fetid pus was discharged both from the canal and the opening. This condition lasted until April 30th, when loose bone was discovered, and a piece of the size of an infant's little finger, was removed by Dr. Roosa.

On May 29th the patient was again placed under ether, and the granulations removed and the carious mastoid cells gently scraped by Dr. Roosa.

From this time until September 23d the wound was dressed twice daily, being cleansed with Labarraque's solution by means of the syringe, and a tent of linen was pushed well to the bottom of the wound. The discharge was very fetid and profuse ; granulations were frequently removed, but no tendency to heal was shown, although the patient was in good health ; she had no head symptoms or pain. The wound was dressed with great difficulty on account of the sensitiveness of the ear to all handling.

The ophthalmoscope showed no lesion or change in the fundus of either eye.

On September 23d it was discovered that a piece of bone not only

filled the entire opening, but caused tumefaction below. On the next day the patient complained of pain in the ear.

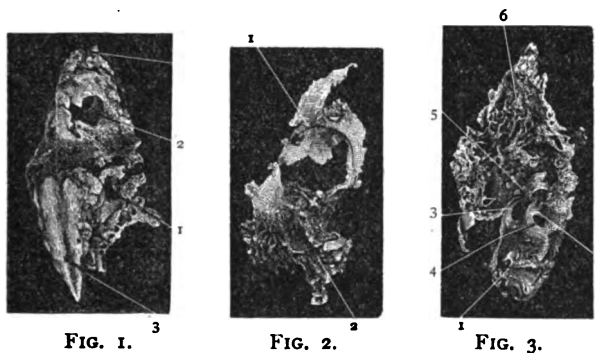
*September 25th.*—The patient was placed under ether, the wound enlarged vertically, and the bone grasped with dressing-forceps and with slight difficulty removed by Dr. Emerson. There was little hemorrhage.

It was found that the portion of bone removed was the whole of the petrous portion of the temporal bone, photographs of which, taken of the actual size, are herewith exhibited.

For a few days after the operation the discharge and odor were greater than ever, fine particles of broken-down bone continually coming away. On the day following, the malleus bone was washed out in perfect condition.

On Oct. 14th another sequestrum, which proved to be the *annulus tympanicus*, was removed, without ether, by Dr. Roosa. Since then there has been great and constant improvement. All discharge and odor disappeared within a week.

*January 20, 1885.*—A fistula of one and a quarter inch in depth remains. The discharge from it is usually not sufficient to soil the dressings. The edges are contracting. It is probable that a permanent but small fistula will remain. See fig. 4.



The first specimen (fig. 1) is the entire petrous portion of the left temporal bone. It measures  $1\frac{3}{8}$  inches in length,  $\frac{3}{4}$  inch in breadth, and  $\frac{5}{8}$  inch in thickness. The posterior surface is considerably eroded, and shows near its centre the first turn of the cochlea (1). Posterior to this is the internal auditory canal (2),  $\frac{1}{4}$  of an inch in depth. At the lower edge is the groove for the superior petrous sinus (3).

The anterior surface shows the eminence for the superior

semicircular canal in perfect condition; anterior to that the bone is eroded, and the tract of the facial nerve where it leaves the internal auditory canal and enters the tympanum is shown. The outer or tympanic surface (fig. 3) shows the following objects: Beginning at the apex, the bony groove for the Eustachian tube (1); in front of that, the promontory (2); above this, the ovale (3); and below, the foramen rotundum (4); above and external to this is seen aquæductus Fallopii (5); and posterior, the mastoid cells (6).

The second specimen (fig. 2) is the annulus tympanicus and part of the bony external auditory canal. The cut is a view of the internal surface, actual size, and shows the groove for the membrana tympani (1) and the mastoid cells



FIG. 4.

(2). It measures  $1\frac{1}{4}$  inches in length,  $\frac{5}{8}$  inch in breadth, and  $\frac{1}{4}$  of an inch in its thickest portion.

The literature of the subject shows that exfoliation of the cochlea is not of rare occurrence. The cases are too numerous for individual reference in this paper, and they are readily found. Exfoliation of the cochlea and semicircular canals is much less frequent. Cases have been reported by Wilde,<sup>1</sup> Agnew,<sup>2</sup> Pomeroy,<sup>3</sup> Blake,<sup>4</sup> Toynebee.<sup>5</sup>

<sup>1</sup> Treatise on Diseases of the Ear, p. 158.

<sup>2</sup> Troeltsch on the Ear, second American edition, p. 471.

<sup>3</sup> Transactions of Amer. Otological Society, 1882.

<sup>4</sup> *Ibid.*, 1880.

<sup>5</sup> *Archiv f. Ohrenheilkunde*, Bd. 1, 1864.

In Toynbee's cases *the sequestra were not removed until after death*. This fact deprives them of much of their importance. Mr. Shaw, of London, has published a case of exfoliation of the whole of the internal ear and part of the petrous bone.<sup>1</sup> As the case so nearly resembles the one here reported, the main facts are quoted :

" Boy, seven years of age, otorrhœa from scarlet-fever two and a half years ago. Facial paralysis of left side, and complete deafness. Left external ear projected considerably beyond its proper level ; irregular piece of bone, surrounded with granulations, protruded from the meatus into the concha." Mr. S. " first extracted the piece of bone which projected into the concha ; this appeared to have been the posterior border of the external meatus of temporal bone. The cartilaginous tube having been ulcerated by the pressure of the bone fragment, the point of the little finger could be passed to some depth, and another piece of bone was felt rolling freely in the cavity ; this was removed with dressing-forceps with some difficulty. Patient made good recovery, paralysis remaining. The bone removed was nearly the whole of the petrous portion of the temporal bone ; it measured one inch in length and one half inch in thickness, and weighed twenty-two grains. On one side, nearly in its centre, was an opening and cavity, the internal auditory meatus. Depth of canal was three fifths of an inch, showing that the whole of the internal meatus was included. On the side of the specimen in relation to the brain the surface presented the cancellated appearance peculiar to diploë, when it was concluded that the process of separation had taken place in the diploë, and that the cortical layer had retained its vitality, and that, remaining in contact with the dura mater, served as a barrier to prevent the disease from extending to the cerebrum. The opposite aspect of the bone shows the inner wall of the tympanum, etc."

Dr. Pollak, of St. Louis has also reported a similar case of loss of the petrous portion of the temporal bone in these ARCHIVES, vol. x., p. 361.

There was no diploë in the case here reported, and the bone showed markings, such as the uneroded groove for the superior petrosal sinus and the eminence, which conclusively

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<sup>1</sup> Transactions of the Path. Soc., Seventh vol., London, 1855.

proves that it was separated from the dura mater throughout the most, if not all, of its extent.

How this could happen without the meninges becoming inflamed, the sinuses obstructed, and the internal carotid artery affected, is not easily seen.

There were absolutely no head symptoms, except the coma occurring during the acute stages of the scarlet-fever. *From this fact, and the fact that the paralysis came on soon (within ten days) after the beginning of the scarlet-fever, we think we are justifiable in thinking that the internal ear and petrous bone were primarily affected with a purulent inflammation, and that it was not, as is generally the case, the result of secondary inflammation extending from the middle ear.*

From the first we maintained a *perfect* and *free* drainage of the products of inflammation, both from the ear and mastoid opening. To this the child is most probably indebted for her life.

The operative interferences were only made when nature, unassisted, proved insufficient for her task of giving a free exit to purulent and dead material. The child took no drug during the eleven months that she was under our care.

## ABSOLUTE LOSS OF HEARING-POWER IN BOTH EARS ACCOMPANYING AN ATTACK OF MUMPS.

By SWAN M. BURNETT, WASHINGTON.

SO long as the direct connection between mumps and loss of hearing-power remains the mystery it is, the thing most needed is an accumulation of as many and as reliable clinical facts as possible. To this end the following case is offered :

John R. Courtney, aged six, was taken with mumps during Christmas week, 1884. Three or four other children in the family had already been attacked, some of them severely, but John's attack was very light. There was very little swelling externally, and internally scarcely any redness or tumefaction was noted. There was no special complaint of pain, and he ran about the house and played in excellent spirits. On the evening of Jan. 1, '85, he was at the table with the other members of the family, and nothing was noticed that called attention to his hearing-power. On the morning of the 2d of Jan. when he got up his brother asked him to bring him his rubber shoes, and he made such an irrelevant answer as led to further investigation of the matter. It was then discovered that he was totally deaf. He could not understand a word though it were shouted into his ears. During the first days after this he would say that he heard beautiful music, and would frequently stagger, and laughingly informed his mother that he was drunk. Aside from this, nothing unusual was noticed or complained of. He was brought to me for examination on the 16th of Jan., and I found the loss of hearing-power complete. The *Mt* were perfectly normal, and there was only a slight redness of the fauces. At that time there was no unsteadiness of gait.

I saw the case once only, but he was seen several times afterward at the Children's Hospital by my assistant, Dr. Kolipinski, who informs me that, up to date, there is no improvement. He has resorted to large doses of quinine, and blistering behind the ear, without effect.

The points to be specially noted in this case are : 1. That the attack of parotitis was very mild ; and the question arises as to whether the force of the morbid influence was not largely spent on the auditory apparatus, and also raises another question as to whether the ear affection was a concomitant affair or a true metastasis. As far as can be ascertained, the deafness came on three or four days after the mumps was first noticed. 2. There can be no question in this case that the deafness is nervous, and any implication on the part of the middle ear can be excluded. The subjective noises and the staggering gait would point to compression in the labyrinth as a cause, and its comparatively sudden onset would indicate an exudation, sanguineous or serous.

## ON THE RELATION BETWEEN THE DISEASES OF THE TEETH AND EARS.

By HENRY DICKSON BRUNS, M.D.

NEW ORLEANS, LA.

NOT a little has been written of late upon the harmful influence of dental irritation and disease on the condition of the ears. Ever since the publication of his prize essay "On Affections of the Ear Arising from Diseases of the Teeth,"<sup>1</sup> Dr. Saml. Sexton, of New York, has been first and foremost in this field, and he it was who, in the winter of 1881, called my attention to the subject. I was struck at the time by the fact that I knew well several persons whose teeth were conspicuously bad, but whose keen and delicate sense of hearing I had frequently noted, and even commented upon. It also occurred to me that if dental affections are common among the class which frequents our large hospitals (and this is well known to be the case), we would, of course, often find them associated with diseases of the ear and defects of hearing in the patients applying at our ear clinics.

Acting on these ideas, I have carefully examined the ears of fifty patients taken at random from the medical wards of the Charity Hospital. These patients had never been seen by me before, and the physicians from whose wards they were taken were, for the most part, entirely ignorant of the condition of their teeth and ears.

The tables,<sup>2</sup> containing the results of my examinations,

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<sup>1</sup> *Am. Jour. of Med. Sciences*, Jan., 1880.

<sup>2</sup> The tables have been omitted for want of space.—EDITORS.



speak for themselves, but the following summary and remarks may not be out of place.

The first point to be determined is the percentage in the class we are dealing with of those having defective teeth. In the table those are set down as having :

Bad teeth in whom	half the back <sup>1</sup> teeth are carious or missing.
Fair " " "	less than $\frac{1}{2}$ , but more than 1 or 2.
Good " " "	1 or 2 back teeth are carious or missing.
Perfect " " "	no " " " "

Taking this standard, the tables show that :

Out of 50 cases	19, or 38 %, have bad teeth.
" 50 "	15 " 30 %, " fair "
" 50 "	9 " 18 %, " good "
" 50 "	7 " 14 %, " perfect teeth.

Ears are said to be perfect when nothing abnormal could be noted at one fairly critical examination, and the Eustachian tubes were pervious (Valsalva's method).

The condition of the ears is, unfortunately, unknown in five cases. Out of forty-five patients, twenty-three have abnormal ears. In seven of the latter the abnormality consists in an excess of wax in *one* meatus; in four, of an excess of wax in *both* meatus; and in thirteen, of some changes in the membrane or other parts of the ear. The ears, therefore, are *absolutely perfect* in twenty-one out of forty-five cases, or in 46 $\frac{2}{3}$  %, while by glancing above we see that the *good* and *perfect* teeth *together* only amount to 32 %, the perfect teeth alone to 14 %.

Hearing is termed :

Perfect, when a loud whisper is heard well at 15 feet.

Good, when a few of the words in a loud whisper are heard at 15 feet.

Fair, " " " " low tone " "

Bad, " " " " loud " " "

Normal, when no deafness was detected during ordinary conversation before the examination.<sup>3</sup>

<sup>1</sup> The incisors are seldom found in such a condition as to lay them open to the charge of exciting ear trouble; nor, so far as I know, has such a charge ever been preferred against them.

<sup>2</sup> Patients were frequently found who were unaware of any defect in their hearing, and in whom a certain degree of deafness was only detectable by a critical examination. In these cases the result of the examination is recorded in the table, the word normal being placed below enclosed in brackets.

In classifying these cases the hearing for the watch was always taken into consideration, although it was never accepted as the standard. It may be noted, however, that in every case in which hearing for the watch was normal, hearing for the voice was absolutely perfect<sup>1</sup>; while on the other hand, in many cases in which no imperfection of hearing for the voice could be detected, there was marked dulness of hearing for the watch.<sup>2</sup>

Out of 50 cases the hearing is	bad in 3, or in 6 %
“ “ “ “ “	fair “ 16, “ 32 %
“ “ “ “ “	good “ 12, “ 24 %
“ “ “ “ “	perfect “ 19, “ 38 %

Certainly these figures, 46  $\frac{2}{3}$  % of apparently perfect ears, 38 % of perfect hearing, and 14 % of perfect teeth, seem to indicate that those cases are exceptional in which dental irritation gives rise to aural affections. But furthermore, the tables show that the side on which hearing is most defective is the side on which the teeth are worse in nineteen out of the fifty cases.<sup>3</sup>

It is also to be observed that none of those whose hearing was “normal” would have applied to an aurist for aid, as their slight impairment of hearing was not noticeable either by themselves, or by those with whom they conversed.

Now, it is not to be denied that in certain cases diseased and painful teeth do give rise to aural affections; but I believe that in such cases severe and long-continued toothache usually plays an important part: hence they are by no means obscure.

On the other hand, an inflamed ear frequently sets up intolerable toothache. I recall one case especially in which the toothache was extreme. An examination of the teeth, however, showed them to be beautifully sound, but had

<sup>1</sup> Case No. 17 comes nearest to being an exception to this rule, but this is explained by the fact that the man understood English very poorly.

<sup>2</sup> In cases 28, 29, 30, and 36 I was unable to get the hearing for the voice, but as the watch was distinctly heard at the extreme normal distance, I have not the slightest doubt that the hearing for a whisper was normal.

<sup>3</sup> This last point is especially suggestive. If affections of the teeth stand but rarely in a causal relation to affections of the ears, we would naturally expect coincidence of sides in about one half of the cases; *i. e.*, utter indifference of relation as to situation.

there been one among their number in that state of chronic and painless caries which we so often see, who can doubt that it would have been triumphantly pointed out as the cause of all the mischief, and promptly pulled?

Another fallacy lies in wait for our reasoning in this matter. Bad teeth and bad ears are both especially common among the scrofulous and feeble members of our laboring classes, and unless we are wary, it is easy to confound coincidence with cause.

Take, for example, the case of the young man of twenty-two, cited by Dr. Sexton in his paper on "Causes of Deafness among School-children" (Circulars of Information of the Bureau of Education, No. 5, 1881). A dentist would have pointed this man out across a room as the probable victim of bad teeth, while an aurist would have been equally sure that an examination would discover disease of the ears.

Finally, I think it may fairly be said: We know that, owing to the intimate nervous connection of the organs concerned, dental irritation may, *at times*, cause aural disease, and *vice versa*; but in the present state of our knowledge we are to regard such causal relationship as the exception rather than the rule.

## CLINICAL NOTES.

By F. M. WILSON, M.D.,

OPHTHALMIC AND AURAL SURGEON TO THE BRIDGEPORT HOSPITAL.

### CASE I.—*Inflammation of the mastoid without pain.*

Carrie P. B., age four. Feb. 16, 1883.—Two years ago she had a mild attack of scarlatina, followed by swelling of her feet and by running ears. The right ear stopped running after several weeks. The left has run ever since, up to three weeks ago, when it stopped, and her head began to swell over the mastoid process. This swelling has steadily increased until now, when it involves the tissues from the mastoid nearly to the outer canthus of left eye.

"The swelling has been poulticed for one week steadily, night and day." (?) Little or no redness; distinct fluctuation; loss of appetite, but no coat on tongue. The child is up and about the house, playing with its toys. Pain is not a prominent symptom, and she permits moderate pressure over the whole swelling without flinching. The child has once or twice, within the last two or three days, been for a few moments "out of its head." Temperature,  $102\frac{1}{4}^{\circ}$  F.; Wilde's incision; tablespoonful of pus. A probe enters the mastoid readily, also passes upward and forward, so that it can be felt in front of and above the auricle. Cloth tent and vaseline.

*February 17th*, 8 A.M.—Temperature  $99^{\circ}$ ; nothing approaching delirium since incision.

*February 21st*.—Changed tent and syringed cavity twice a day on 17th and 18th, and once a day on 19th and 20th. This afternoon, being urgently called, I saw her and was told that "she had a convulsion about ten o'clock"; "it lasted about five minutes"; "it was not a chill"; "she has been sleepy and stupid since." I made the tent smaller and shorter yesterday, and to-day found

it wholly out of the wound. Temperature, 104° F. ; pulse, 140. I could find no distinct pocket of pus. Slight swelling and tenderness over the parotid gland. The cavity was thoroughly cleansed with the syringe, and large tent renewed. 9 P.M., the patient is sleeping quietly ; pulse, 120.

*February 22d*, 8 A.M.—Pulse 120 ; temperature, 101°. 9 P.M., pulse, 130 ; temperature, 103°.

*February 23d*, 8 A.M.—Pulse, 120 ; temperature, 101°.

*March 21st*.—Temperature and pulse came down to normal, within two to three days after last record. Changed tent twice a day up to March 1st. Have touched no bare bone with probe for at least three weeks. Have never, with syringe or probe, been able to positively demonstrate communication with tympanic cavity or external meatus. Abscess cavity is about one third filled, chiefly from above. Pus began to come from tympanic cavity again during the last week in February.

*April 2d*.—Cavity two thirds filled and discharging very little. Ear discharging freely.

*April 6th*.—Discontinued tent.

*April 9th*.—External opening closed. Free discharge from tympanum.

I have never before seen pus, which undoubtedly came from the mastoid, burrow upward and forward to a point in front of and above the auricle. The comparative absence of pain, redness, and constitutional symptoms is certainly unusual. The most serious symptoms which she had at all followed immediately upon the ill-judged lessening of the size of the tent.

I should say that the outer bony wall of her mastoid must have been very thin, or perhaps wanting altogether. Just why water would not pass from the open mastoid into tympanum, or *vice versa*, I am unable to explain.

*CASE 2.—Acute inflammation of the middle ear ; death in fifteen days.*

A. C. C., aged about forty. Aug. 26, 1884.—While bathing at Coney Island five days ago "got some water in his left ear" ; the next day commenced to have earache, which has persisted since ; and yesterday "the bone behind his ear began to pain him." Left *Mt* red ; slight pain on firm pressure over mastoid ; no

redness ; countenance anxious ; hands tremulous ; temperature, 99° ; pulse, 80. Is so much frightened by any suggestion of danger that I make light of his trouble, but keep him in bed. Hot water and large cotton pad.

*August 27th.*—Not much change. Still complains of "pain in the bone behind his ear." Three leeches on mastoid.

*August 28th.*—The leeches gave him immediate and complete relief from pain. I find him up and dressed, and only by much persuasion induce him to remain in-doors. Am to see him again on the 30th, or before, if he sends word.

On morning of 30th he informed me by telephone that he thought he was well enough to go to business the next morning. Eleven days later he died (comatose), and Dr. F. J. Young, who was called just before his death, gives me the following facts. He was up and around for about eight days ; then had a return of pain, but the most prominent symptom was mild delirium. He was sick enough so that his friends kept him in bed, but did not think there was much the matter with him. He would be rational enough part of the time, but would do many strange things—would order them out of the room, and at times would refuse to do any thing they suggested. He took some morphine, and vomited after it. There was no paralysis. Slight redness over mastoid, but no swelling. These symptoms—pain in ear and mastoid (but not severe), delirium at intervals, and vomiting—were the only prominent ones up to the morning of the day he died, when coma came on and continued until his death in the afternoon. An autopsy was not obtainable.

This case is reported from a conviction that every case of the kind, no matter how incomplete the details, should be put upon record.

*The aural history of a syphilitic family.*

A. B. C. is now about forty years old. Seventeen years ago he contracted syphilis. The sore on the penis was followed by a bubo in each groin, and, later, by a copper-colored skin eruption, scabs in his hair, and loss of flesh and strength. About 1870 he came under the care of Dr. R. Hubbard, of Bridgeport, Conn., and was under treatment nearly all the time until 1880. His principal symptoms were sore throat and disease of the right femur. The throat trouble was intermittent, and always yielded

readily to treatment. The disease of his femur was near the lower end, and as he would not keep still, but insisted on walking about, it kept him lame from about 1873 to 1880.

Since that time he has had no symptoms. He admits that he infected his wife, but cannot tell whether she had a primary sore or not. He does remember that she had a copper-colored scaly eruption all over her body.

At the time of her first pregnancy, about fourteen years ago, both were free from symptoms, except that he had sore throat. She, however, miscarried at six weeks. Also in the next pregnancy she miscarried at two months.

Their first living child, a girl, is now thirteen years old. A discharge of pus from both her ears began when she was three months old; they discharged steadily for three years. In that time, though quite deaf, she learned to talk, but her hearing got worse and worse, and she forgot many of the words she had learned. I saw her March 8, 1880, and made the following record in my case-book: "Hears loud gong-bell on right side, three feet; not at all on left. Blake's tuning-fork, when placed on vertex or teeth is heard on right side, but is not heard through the air; drum membranes gone, and probably, also, the ossicles." This girl is being educated as a deaf-mute. She has taken Hg and KI. in large quantities since becoming deaf, but she did not take them when her symptoms first appeared.

The second living child, a boy, is eleven years old. I first saw him Jan. 26, 1885. His ears both discharged when he was a baby, but this discharge ceased in a few weeks after taking mercury and iodide of potassium. He has had no trouble since, until a few weeks ago, when his father noticed that he did not seem to hear well, and that he kept getting worse every day. He has complained very little of pain, but if questioned, he would always admit that his ears "ached a little."

The R *Mt* was red over its entire surface, but light spot not entirely obliterated; circular scar 3 mm. in diameter behind and below handle of malleus.

The L *Mt* was uniformly purplish red, less concave than normal, no light spot; linear scar about 3 mm. in length directly behind handle of malleus.

There was no pharyngeal or nasal catarrh; bone-conduction best in both ears.

$$R\ E, W = \frac{1}{4} \text{ after infl. } \frac{1}{4}$$

$$L\ E, W = \frac{1}{4} \text{ after infl. } \frac{1}{4}$$

Somewhat anæmic. Has been taking KI for several weeks. I prescribed inflation and syr. ferri iodidi. He has one oval brownish scaly patch on his right temple, and a small indolent ulcer on inner surface of lower lip. After two weeks' treatment, R E, W =  $\frac{8}{16}$  L E, W =  $\frac{6}{16}$ ; appearance of drum membranes about the same.

In the fifth pregnancy miscarriage occurred at 3-3½ months, which was attributed to riding over rough roads.

The next child, a girl, died, when a few months old, of *brain trouble*.

The third living child is a boy, age six, healthy. In eighth pregnancy miscarriage occurred at two months, attributed to lifting.

The fourth living child is a girl, age three, healthy. The fifth and last living child, now fourteen months old, had, when a few months old, "*running ears*," which stopped running in a few weeks *after taking* mercury and iodide of potassium.

On January 27, 1885, I was called to see the child, and found subacute otitis in both middle ears, also cicatricial drum membranes, also on various parts of its body brownish spots from  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in diameter. Feb. 17, 1885, Dr. Hubbard tells me that the baby has measles, and that its ears are running again.

The history of this family shows that we have a father undoubtedly syphilitic, and the mother probably so. We have four miscarriages. We have one child who lived only a few months, and died of *brain trouble*. We have five living children. Of these, three had suppurative otitis media *within a few months after birth*. In the oldest child the disease was progressive, and finally involved the internal ear, making her a deaf-mute. No one remembers that she took any mercury or potash until her ears had run at least two years.

We have in the next child a suppuration of middle ears which got well after taking the drugs just mentioned, and subsequently subacute inflammation of middle ears. We then have two healthy children, and lastly a baby fourteen months old, and he also has had suppurative inflammation of both middle ears, which disappeared after taking Hg and KI, and has since had subacute otitis media, which afterwards became suppurative during an attack of measles. It should be noticed that he was born two to three years after father's symptoms had ceased.

The history I think can be relied upon. The father is an



intelligent man, and has never shown any disposition to evade inquiries, but rather sought to facilitate them. Dr. Hubbard has had this family under constant supervision since 1870, and is too acute an observer to have been misled upon any important part of the history. The statements taken from my case-books were recorded at the time the observations were made, and I think are in the main correct.

There are, it seems to me, three ways of explaining the otitis: First, we may deny the influence of the syphilis altogether; secondly, we may admit its influence indirectly by lowering the vitality of the children; and thirdly, we may infer a specific deposit of syphilitic poison in the mucous membrane of the tympanum itself, affecting it as it does the mucous membrane of the throat. I am free to confess that the facts do not justify any dogmatic choice between the three.

Theoretically I can see no reason why syphilis should not manifest itself locally in the mucous membrane of the tympanum, as well as in the mucous membrane of the throat; practically I am led to disbelieve it from the fact that I have seen many throats affected and no tympana (in which I felt sure of the specific origin), and also from the fact that there is little or no literature upon this point.

It is very easy where there is a syphilitic taint in a family to attribute every thing to it, but I think that no thoughtful man could study this family history without having it forcibly suggested to him that the otitis media of these three children might be a local manifestation of hereditary specific poison.

# THE COMBINED MANOMETRICAL EXAMINATION AS AN AID IN THE DIAGNOSIS OF EAR DISEASES.

BY A. EITELBERG, OF VIENNA.

Translated by Dr. J. J. B. VERMYNE, of New Bedford, Mass.

THE manometrical examination of the organ of hearing, for physiological and diagnostical purposes, has been cultivated so thoroughly and extensively by many excellent investigators—I mention only Politzer, Lucae, and Hartmann,—that further studies do not promise to yield new results of much importance. In my experiments I have principally aimed at ascertaining the diagnostic value of this method, as compared with other well-known methods; in particular, to point out such cases as can correctly be diagnosed by the new method alone. For this purpose I have used both the metallic manometer, as used by Urbantschitsch,<sup>1</sup> and the aural manometer, described by Politzer,<sup>2</sup> singly and also often in combination.

The difficulty of securing an air-tight closure of the external meatus by one end of the aural manometer is a matter which many observers have endeavored by various means to overcome. Fick<sup>3</sup> used in his experiments a glass tube, several inches long, open and thick at both extremities and of very narrow calibre (thermometer tube). Around the end to be introduced into the external meatus, he wound a

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<sup>1</sup> "Lehrbuch der Ohrenheilk.," 1. Aufl., 1880, p. 30.

<sup>2</sup> Sitzungsberichte der mathem.-naturwissenschaftlichen Classe der K. K. Academie d. Wissenschaften, 1861, Bd. xliii., pp. 427-438.

<sup>3</sup> Müller's Archiv f. Anatomie, etc., 1850, pp. 526-528.

strip of vulcanized rubber, until "a plug was formed, about the size of the meatus at its entrance in the petrous bone." It is a matter of course, that before using this or Politzer's aural manometer the ear should be cleared of any cerumen, which, by closing the tube, would make the experiment useless. Politzer's manometer is furnished at its aural extremity with a piece of cork or rubber, corresponding in form with the entrance to the meatus auditorius externus, and which, previous to introduction, is lubricated with tallow.

In this manner, however, a gradual loosening of the aural manometer within the meatus and a consequent interruption of the experiment can hardly be avoided. Lucae<sup>1</sup> has found in previously heated gutta-percha a practical means for obtaining a permanent hermetic closure. Of this fact one can easily convince himself during the action of the muscles of the lower jaw, whereby the external meatus is alternately narrowed or widened, and consequently changes must occur in the position of the fluid in the aural manometer.

To the horizontal extremity of Politzer's manometer I have attached a rubber piece in the form of a truncated cone, and this being lubricated with vaseline, the instrument is introduced into the meatus, and, notwithstanding the difference in volume of the meatus in the persons experimented upon, I have obtained hermetic closure in many cases. If this, however, did not succeed, I have been more fortunate by winding around the rubber end-piece a layer of cotton-batting lubricated with vaseline, corresponding in size with the capacity of the meatus in question. Thus it has often occurred that the fluid entirely entered into the meatus externus. For the manometrical fluid I now—after many unsuccessful attempts with other colored fluids—use exclusively carmin. On introducing the aural manometer the carmin first mounts to the border of the outer end of the manometer, and if the instrument is left to itself, unsupported, the fluid falls in the ascending part of the instrument, rises gradually in the descending part, and at the

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<sup>1</sup> *Archiv f. Ohrenheilk.*, Bd. i., pp. 96-106.

slightest effort to remove the manometer from the meatus, it entirely enters into the meatus. In some few cases where the aural manometer, hermetically introduced, had been left to itself, the escape of the carmin into the meatus took place so rapidly, that further experiments could not be made. This has occurred especially in cases with extensive or total destruction of the *Mt*, or, if this membrane was intact, in cases where the meatus was very wide and long.

I think the physical explanation of this phenomenon is as follows: By the forcible introduction of the manometer into the external meatus the latter becomes mechanically shortened in its longitudinal axis, on account of the mobility of the cartilaginous part. The column of air contained within the meatus, being compressed into a smaller space, increases in density, and forces the drop of carmin outwards. If the manometer is no longer supported by the hand, its own weight causes outward traction; the external meatus is again drawn out, the air becomes less dense, and the fluid within the manometer is aspirated. This aspiration becomes easier if large perforations exist, because the air of the meatus can then escape into the tympanic cavity and the mastoid cells, and the rarefaction of air takes place more promptly. Notwithstanding the partial change of position of the aural manometer, the hermetic closure remains the same, which is proved on the one hand by the occurrence above mentioned, and on the other hand by the fluctuations of the fluid, produced by action of the muscles of the maxilla inferior. During the experiment, however, this action must be carefully avoided. Nevertheless,—in order to guard against mistakes,—it is necessary that the position of the manometer is accurately controlled, and the result obtained should be considered correct only when repeated experiments at the same session give approximatively the same figures. Manometrical examinations at different intervals, in the majority of cases, manifest marked differences. This fact was already stated by Politzer (*l. c.*), and from his manometrical experiments he drew the following conclusion: The walls of the tubæ adhere more or less closely, not only in different persons, but also in the same person at

different times, so that oftentimes a large, and at other times a slight, difference in pressure suffices to separate the walls.

As has been stated at the beginning of this paper, my object was especially to study the value of manometrical examination as an aid to diagnosis. In twenty individuals in whom the experiments were frequently repeated, I pursued the following *modus operandi*. By means of auscultation during the application of the catheter or of Politzer's method by the introduction of bougies, and, in appropriate cases, by the rhinoscope, I endeavored to obtain a correct idea of the condition of the tubes. Next I examined the *Mt*, as regards its mobility, with Siegle's speculum, and then applied the metallic manometer. In using this instrument I endeavored to ascertain, by auscultation, the smallest amount of pressure needed for ventilation of the tympanic cavity in Politzer's experiment during the act of swallowing, pronunciation of "hck," or sounding the vocals, and also in the application of the catheter. I then combined the use of the metallic manometer with that of Politzer's aural manometer, in order to notice the lowest degree of pressure needed, in the different methods of inflation, to produce a change in the column of fluid in the aural manometer.

With regard to the value of auscultatory murmurs for diagnostic purposes, it is a fact that they offer but few reliable points for diagnosis of ear diseases. Magnus<sup>1</sup> has thus stated "that our judgment from results of auscultation has but slight actual foundation, and the origin of the auscultatory sounds is exceedingly complicated." According to this author, not only is the escape of air at the beak of the instrument in the fossa triangularis of the utmost importance, but there are also sources of error in the force-pump or inflators, whereby the interpretation of auscultatory sounds is made very difficult. A decisive proof of the unreliability of these sounds in judging of the width of the tubes has been given by Urbantschitsch.<sup>2</sup> In a series of cases he found, by application of the bougie, narrowing of

<sup>1</sup> *Archiv f. Ohrenheilk.*, Bd. vi., pp. 246-262.

<sup>2</sup> *Wiener med. Presse*, 1883, Nos. 1-3.

the tube, especially at the isthmus, while from the character of the auscultatory sounds apparently no obstacle existed against free entrance of air. On this ground Urbantschitsch in diseases of the middle ear, and especially in chronic catarrh of the middle ear, always practises the introduction of bougies in the Eustachian tube.

From these observations it is shown that the importance of manometrical examinations, especially when simultaneously performed with the aural and metallic manometer, is not to be underrated. We can, however, not ignore the fact that in one case, where the isthmus only admitted a bougie of  $\frac{3}{4}$  mm., with an atmospheric pressure (0.06) corresponding with the normal volume of the tubes, air passed into the tympanic cavity during the act of swallowing in Politzer's experiment or during catheterization. Of this I became thoroughly convinced, not only by auscultation, but also by the change in the manometrical fluid.

It ought here to be mentioned that, with regard to the results of the examination, it is not always matter of indifference whether one uses a short catheter, unprovided with a special arrangement for receiving the air-bag, or an olive, by which hermetic closure is more easily obtained. Hartmann<sup>1</sup> closes the nasal cavity by means of a double olive, one connected with the inflating apparatus, the other with a mercurial manometer.

I will now more especially consider the value of manometrical examination for diagnosis of diseases of the tuba, particularly with regard to its calibre, in order to ascertain how far this method enables us to judge of the free, or more or less defective, mobility of the membrana tympani.

In regard to the first I have shown more in detail in another paper,<sup>2</sup> that by means of this examination we are able to diagnosticate stenosis of the tubæ at their pharyngeal aperture. A. Hartmann<sup>3</sup> succeeded in this manner to define the degree of constriction in a boy of fourteen, who exhibited symptoms of tubal stenosis. In this patient at

<sup>1</sup> Experimentelle Studien über die Function der Eustachi'schen Röhre, Leipzig, 1879, p. 30.

<sup>2</sup> Zeitschr. f. Ohrenheilk., Bd. xiii., pp. 132-145.

<sup>3</sup> Virchow's Archiv, Bd. lxx., pp. 447-460.

an expiratory pressure of 130 *mm.* Hg., no air penetrated into the tympanic cavity; during deglutition a pressure of 80 *mm.* was needed for the left, and of 100 *mm.* for the right, side. After introduction of the catheter the air entered on both sides at a pressure of only 10 *mm.* It may here be observed that, according to the experiments of Hartmann (*l. c.*), Urbantschitsch,<sup>1</sup> and myself, a pressure of 10 *mm.*, or a little above, suffices in Politzer's experiment to force the air through a normal tube into the tympanic cavity during the act of swallowing.

(While performing Politzer's experiment with pronunciation of "hck," or sounding the vocals, an atmospheric pressure just a few hundredths greater is necessary for ventilation of the cavum tympani. If, however, in Politzerizing while swallowing, a pressure of over 0.1 atm. is needed, the relative difference of pressure for the same purpose in the same case during the pronunciation of "hck" or sounding the vocals will be 0.1, to 0.15 atm.)

According to Hartmann, we obtain by this method a definite measure of the swelling of the tubæ, whereas a diagnosis of this swelling from the auscultatory sound, as heard during catheterization, according to the above statement, is not very reliable. Among the individuals experimented upon by myself were three cases of tympanitis purulenta chronica—in two cases bilateral—and one case of chronic catarrh of the middle ear, where by Politzer's experiment with swallowing a pressure of 0.2–0.3 atm. (0.1 atm. = 75 *mm.* Hg.) was necessary for ventilating the cavum tympani—that is, for mobilization of the column of fluid in the aural manometer, while in catheterization a pressure of 0.03–0.08 atm. sufficed. This method, however, only gives us light with regard to swelling of a part of the cartilaginous-membranous tube. For if we consider that this cartilaginous-membranous tube in the adult is 24–30 *mm.* long, while the end of the catheter, in the most favorable circumstances, does not penetrate farther than about 10 *mm.*, it follows that by manometrical examination swelling of the Eustachian tube can be diagnosticated with certainty only

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<sup>1</sup> "Lehrbuch der Ohrenheilk.," 1880, 1 Aufl., p. 29.

when occurring at the pharyngeal third. If stenosis exists beyond this third, or in the osseous tube, the bougie has to be resorted to in order to ascertain the seat of the stenosis.

Another pathological process in the diagnosis of which manometrical examination affords great service is paresis of the tubal muscles, described by Weber-Liel. The diagnosis of this disease is based upon "the marked incongruity of the tactile and acoustic results of the examination." While the tube, even in the later stages of the disease, retains its permeability for large bougies ( $1\frac{1}{4}$ – $1\frac{1}{2}$  mm.), the auscultation sounds become gradually duller, as coming from a distance, and are often only recognizable by resorting to swallowing.<sup>1</sup> In alternating rarefaction and compression of the air in the external meatus by means of Siegle's speculum, the *Mt* is easily movable. That the tube is almost completely impervious to air, notwithstanding the possibility to introduce large bougies through the isthmus, is proved by the fact that if we attempt to force air into the tympanic cavity under great pressure, no change is observable in the fluid of the aural manometer, although on the part of the *Mt* or the tympanic cavity no obstacle exists.

Among my twenty subjects for manometrical experiments were two of these cases already in an advanced stage of the disease. One was a man over sixty, the other a woman of thirty. In both cases the tube easily admitted bougies of  $1\frac{1}{2}$  mm., and the membr. tymp. were movable on examination with Siegle's speculum. In the first case I still observed a dull, thin auscultation sound during catheterization, with a pressure of 0.12 atm.; in the second case a similar sound was obtained with 1.08 atm. On the other hand, however, during the same process of catheterization, the fluid in the manometer remained unmovable with a pressure of 0.3 atm. (= 225 mm. Hg.). Hence a comparative small pressure during inflation may produce a sound, however dull and distant, while at the same time it is impossible to force the air into the tympanic cavity by using a much higher pressure. I believe, therefore, that through the combined manometrical experiment we do gain a decided point

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<sup>1</sup> Weber-Liel, *Progressive Schwerhörigkeit*, Berlin, 1873, pp. 30-33.



for the diagnosis of relaxation of the tubes, and especially for the extent of the affection.

The manometrical experiment will also enlighten us with regard to an anomaly of the tubes, in the diagnosis of which, even the bougie leaves us rather in the dark, while catheterization and inflation in general only give partial disclosure. I have, as yet, not met with a typical case of this disease during my manometrical experiments, as the anomaly of which I am speaking occurs but rarely. I refer to flexions of the cartilaginous-membranous tube, or, what occurs more frequently, the osseous tube. At the point of flexion the bougie will meet an unsurmountable obstacle; perhaps auscultation may reveal a normal sound, but the positive result of combined manometrical experiments—metallic or mercurial and aural manometer—can only decide for a free passage of air through the tube. Of course it is premised that tympanic cavity and *Mt* are in a healthy condition, a fact which can be positively ascertained. Based upon the results of the combined manometrical examination, the length of that part of the bougie from the end of the catheter to the seat of the obstacle will enable us to judge whether the flexion exists in the cartilaginous-membranous or in the osseous part of the tube.

Finally, this method renders it possible to recognize subacute swelling of the mucosa of the tube, which is not infrequent in the course of chronic middle-ear disease, and with more accuracy than by tactile examination. Of this I became convinced in four typical cases of subacute swelling. In these cases I still succeeded, with a little trouble, in passing the bougies, which usually passed through the isthmus, but in order to carry the current of air into the tympanic cavity, and to produce a change of level in the manometrical fluid, a much greater pressure was needed. An acute or subacute catarrhal swelling, so long as it remains soft, and has not attained the degree of consistent infiltration, is easier overcome by a solid object than by a current of air. A temporary occlusion of the tubes, as by a plug of mucus, can be safely excluded, as repeated inflations previous to manometrical examination and probing the tubes certainly would have removed such an obstacle.

Assuming that the action of the tubes is normal, the degree of mobility of the *Mt* can also be estimated by the method of examination in question.

In the first place, the respiratory movements of the *Mt* can yet be recognized by manometrical observation, when ocular inspection fails. It is known that, according to Lucae (*l. c.*), the fluid in the manometer shows in the majority of people a positive fluctuation at inspiration, a negative one at expiration, while only in a small number of cases the reverse occurs. This diversity of movement of the *Mt* depends, according to the same author, upon the kind of movement of the soft palate during respiration. Accordingly, as in the act of inspiration—or expiration—the soft palate rises, air will penetrate into the tympanic cavity in either one or the other period of respiration; the *Mt* will then be pushed outward, and the manometrical fluid will show a positive fluctuation, while during expiration—or inspiration—a negative fluctuation occurs.

Differing from the fluctuations in the manometrical fluid which are produced by the respiratory movements of the *Mt*, are those coincident with the frequency of the pulse, and which have been observed by Politzer and Lucae. The latter author believes that they indicate “changes of volume depending on pulsation.” I am not able to decide whether these fluctuations of the manometrical fluid depend upon movements of the *Mt* itself produced by the pulse. This is a question already raised by Lucae. I have been able to observe them in two cases attended with large defect of the *Mt*.

For the sake of completeness, mention should yet be made of those fluctuations of the manometrical fluid which are produced by involuntary contraction of the muscles at the entrance of the ear during intent listening, and this circumstance Gellé<sup>1</sup> suggests to be employed as a means of detecting simulation, because a conversation in whisper, of interest to them, will cause them to listen. It is obvious that in this, as in all other observations of this character, swallowing and movements of the jaw should be carefully excluded.

<sup>1</sup> *Canstatt's Jahrbücher*, 1877, Bd. i., p. 479.

For his experiments in the production of artificial deafness Cassels<sup>1</sup> also uses Politzer's aural manometer, in order to demonstrate the rapid rarefaction of air in the tympanic cavity, when swallowing is practised a few times with closed nostrils. Already after the third swallowing the mercury—which he uses instead of carmine or sulphuric ether—has entirely escaped into the meatus auditorius externus, into which the manometer has been hermetically introduced. This proves considerable degree of retraction of the *Mt*. When Cassels performed the same experiment under ocular inspection of the membrane, it became in a very short time strongly concave, in conformity with the result of the manometrical observation. Besides this, congestion of the blood-vessels of the manubrium, and subsequently of the other blood-vessels of the *Mt*, is observed, with a general confusion and a lowering of all tones, at times also with tinnitus. It is a matter of course, that Cassels experimented only on persons with healthy organs of hearing.

The air, which during the act of suction (aspiration) becomes condensed in the naso-pharyngeal cavity, also penetrates into the tympanic cavity, although a distinct positive fluctuation of the manometrical fluid is not always evident.<sup>2</sup>

According to Politzer, (*l. c.*), adhesions of the *Mt* can be easily demonstrated by the aural manometer. But it is obvious that this only refers to extensive, or even rather complete, adhesion of the *Mt* to the opposite tympanic wall, or to adhesion of the membrane with the corresponding mucosa tympanica. Partial adhesions, especially when not caused by too short or too firm bands—the products and remnants of past inflammatory processes within the cavum tympani,—cannot be demonstrated by the aural manometer, because the *Mt* is only partially obstructed in its excursions during ventilation of the tympanic cavity, and therefore still shows its influence upon the column of air in the external meatus, and consequently upon the position of the manometrical fluid. A slight degree of fluctuation in the

<sup>1</sup> *Zeitschr. f. Ohrenheilk.*, Bd. xiii., pp. 126–131.

<sup>2</sup> V. Lucae: *Virchow's Archiv*, Bd. lxiv., pp. 476–504.

manometer, produced by alternating condensation and rarefaction of air in the tympanic cavity, does not allow us to judge with regard to existing adhesions. For supposing the experiment to be made with entirely normal tubes, the degree of these fluctuations gives a measure for determining the greater or less mobility of the *Mt*, but does not indicate whether or not it is adherent at a certain point. In such a case examination by Siegle's speculum will be of service.

But by means of the manometrical experiment in connection with the result of other methods of examination, we can, at least with a great degree of certainty, judge of the rigidity of a totally thickened drum-membrane. I was enabled to do so in one case, that of a well-preserved man of sixty, suffering for many years from chronic middle-ear catarrh. The naso-pharyngeal cavity was entirely normal. The isthmus tubæ of either side easily permeable by a bougie of  $\frac{1}{4}$  mm. During swallowing in Politzer's experiment, also in catheterization, the tubes admit the current of air at a pressure of 0.05 atm. easily, for, on auscultation, a near, broad, and soft percussion sound is heard, *Mt* but little retracted, and manubrium almost in normal position. But the transparency of the *Mt* has entirely disappeared, the membrane is thickened and immovable on application of Siegle's speculum. The patient states that there never was any purulent inflammation of the middle ear. At the combined manometrical examination with a pressure of 0.35 atm. (the highest pressure I could reach in using the metallic manometer), I had a negative result with regard to mobility of the membrana tympani. I felt, therefore, justified to diagnosticate this case as one of high degree of rigidity of the *Mt*.

A consideration of the facts discussed in this paper shows that the combined manometrical examination is of decisive importance in the recognition of certain morbid processes and anomalies of the middle ear, whereas in others it furnishes valuable additional data to make the diagnosis more accurate.

## ON LACUNAR CARIES OF THE HANDLE OF THE HAMMER.\*

BY PROF. S. MOOS, OF HEIDELBERG.

Translated by J. A. SPALDING, M.D., Portland, Maine.

(With figure 1, plate 1.)

THE extraordinary vascularity of the ossicles of hearing is very favorable to the development of caries. Yet, so far as I know, no one has ever observed or described a case of *primary caries* of these bones. The hammer is the one most frequently attacked, the stirrup most rarely. The immunity of the anvil from the disease, in comparison with the frequency with which it attacks the hammer, does not in my opinion depend upon the slighter vascularity of the anvil, but upon the circumstance that in those severe suppurative inflammations of the tympanum which are likely to be followed by caries of the ossicles, the anvil, being but loosely fastened to the adjoining ossicles and tissues, is almost invariably exfoliated *in toto* at a very early stage of the suppuration, and before caries can attack it. Thus we frequently find that when the suppurative inflammation has in some peculiar way produced an abnormal rigidity and fixation of the hammer so that the anvil cannot be exfoliated as usual, the latter ossicle suffers from caries just as frequently as the hammer.

Allow me now to suggest that caries of the handle of the hammer is really of more value to general pathology than

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\* A paper read before the Third International Otological Congress at Basel, Sept. 2, 1884.

to otology alone. Those things which happen on a large scale are frequently repeated *in petto*, and there is scarcely any object more easy to handle, or more suitable to investigate, or one in which we can better study all the finer processes of caries as we have become acquainted with them on the extremities of the larger bones, than the carious handle of the hammer.

My investigations into the blood-vessels and circulation of the membrana tympani and handle of the hammer<sup>1</sup> have demonstrated that the latter is but slightly nourished by the arterial blood from the cutis, because it is covered at both of its angles and at its inner surface—in other words, upon the greatest part of its circumference—by the mucous membrane, which is rich in blood-vessels, and *mainly* furnishes the material for the nourishment of the handle of the hammer. The mucous membrane, therefore, must first be diseased before caries can attack the handle of the hammer.<sup>2</sup>

It is a well-known fact that the mucous membrane of the *Mt.* during a suppurative inflammation of the tympanum, suffers from a hyperplasia which is partly caused by an infiltration of round cells, and still more by an infiltration of pus cells as well as by enlargement of the blood-vessels. At this time the mucous membrane frequently measures  $\frac{3}{8}$  mm. or more in thickness, and may remain in this condition until death. In other cases, however, the suppuration produces dissolution and exfoliation of the mucous membrane, the latter process being the first condition necessary for the development of caries of the handle of the hammer. The membrana propria, which envelopes the handle of the hammer, and the periosteum also, are now attacked, undermined, and stripped off by the suppuration, whereupon an extremely vascular granulation-tissue forms now at one spot, now at another, upon the inner surface of the periosteum. As the granulations increase in size and coalesce with one another the tela ossea is gradually dislodged. The proliferation of the granulation-tissue, when once established, can extend in all directions, as well up-

<sup>1</sup> These ARCHIVES, vol. vi., p. 574.

<sup>2</sup> It is also possible that caries of the handle of the hammer may be caused by suppurative destruction of its lateral periosteum.

ward and downward as in a transverse direction, while if the process continues for any length of time, the periosteum and the membrana propria itself may be partially or even wholly destroyed. During this destructive process, however, some portions of the tela ossea, especially those in the centre of the handle, may remain intact, under which circumstances, when observed in transverse sections under the microscope, they appear in the shape of infinitesimal sequestra still held *in situ* by the granulation-tissue. Finally, these also yield to the destructive process or melt away. We then see nothing except a bit of bone more or less closely in contact with the lateral periosteum, or else that part of the handle concerned is entirely destroyed, and the handle is in this manner shortened by caries and necrosis, or the entire handle as far as the head of the hammer is lost.

Under the name of *lacunar caries*, we understand that form of deliquescence of the bony tissue in which the edge of the undermined portion always exhibits a characteristic line composed solely of small arcs of a circle. It is chiefly produced upon the handle of the hammer by the indirect action of granulation-tissue, rarely by the action of giant-cells. Indeed, these cells are frequently absent in cross-sections of the lacunæ, while in others we meet with them but rarely, and even then they do not invariably lie upon the inner surface of the cavities, but scattered irregularly amidst the granulation-tissue, now oval, now round, and sometimes with from three to eight or even more nuclei. Occasionally also we see them lying together in enormous groups, one giant-cell overlying another along the entire arched boundary line of the lacuna.

It is an interesting fact, so far as the osteoclastic theory is concerned, that in cases of caries of the handle of the hammer, the osseous tissue is for the most part pushed back by granulation-tissue and only partially by multinuclear cells. Thus, for instance, Pommer, who has lately studied this subject very carefully,<sup>1</sup> denies that granulation-tissue has any share in the formation of resorption-lacunæ in the

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<sup>1</sup> On the Osteoclastic Theory, *Virchow's Archiv*, Band xcii., 1883.

*physiological* growth of bone, and decides in favor of the osteoclasts as the real resorption-organs of the bony tissues. In my opinion, however, *both of these processes are possible in pathological cases*, and in such the granulation-tissue has a greater share in the resorption of the bony tissue than the multinuclear or giant-cells. According to previous theories, it used to be generally assumed that the multinuclear cells originated at one time from inclusion and at another from confluence of the granulation-cells, and finally from multiplication of the cellular protoplasm and subsequent division of the nuclei. Pommer, however, explains their origin by local increase in the blood pressure, whereby we have an increased transudation, and alteration of the processes of diffusion, so that the growth of the cells is favored, and those next to the bone obtain osteoclastic properties. Finally, according to the same author, similar occurrences may come to pass in inflammatory processes.

#### *Explanation of the Figure.*

This exhibits a cross-section through the torso of the middle of the handle of the hammer. Hartnack,  $\frac{1}{4}$ . The mucous membrane is everywhere absent from the remnants of bone. The greater part of the tissue lying between the crumbled bone is composed chiefly of very vascular granulation-tissue. On the contrary, the lacunæ in the bone lying almost wholly to the left are filled with multinuclear so-called giant-cells. The lacunæ themselves are sharply defined against the remaining bony tissue by larger or smaller arc-shaped borders. At *s* sequestra held *in situ* by granulation-tissue.

The periosteum and perichondrium, together with the osteoid tissue, situated upon the periphery of the handle, are only preserved at the right half of the specimen, and at *mp* are united with the membrana propria which extends to the membrana tympani (omitted in the figure).

*RA*, direction of the cross-section toward the external auditory meatus.

*RT*, direction of the cross-section toward the tympanic cavity.



## ON VASCULAR VILLI OF THE TYMPANIC MUCOUS MEMBRANE.\*

BY PROF. S. MOOS, HEIDELBERG.

Translated by J. A. SPALDING, M.D., Portland, Maine.

(*With figure 2, plate 1.*)

GERLACH has already described various microscopic elevations of the mucous membrane of the membrana tympani, some globular, like the papillæ of the tongue, and some finger-shaped, like intestinal villi. The former, according to Gerlach, attain so enormous dimensions that they can be seen with the naked eye in transmitted light. They are composed, centrally, of the common sort of connective tissue, but at the periphery, of a more homogeneous connective tissue, and contain one or more vascular loops, but no nerves. They are covered with a single layer of pavement-epithelium. They are more numerous on the membrana tympani of new-born children, and as some of them are connected with the mucous membrane of this membrane with pedicles only, Gerlach thinks that they ought to be called villi of the membrana tympani.

Many preparations of my own confirm this assertion of Gerlach's. Some of them are longitudinal sections made from the circumference of drum membranes, treated with osmic acid, of the new-born and of infants in the first weeks of life. In these specimens we obtain so excellent a topographical view of the villi that we can easily count them.

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\* A paper read before the Third International Congress at Basel, September 3, 1884.

In the course of histological investigations, which I was carrying on for quite different purposes, I twice had an opportunity of discovering *villi of the inner tympanic wall*.

The first case was that of a child which came into the world in an asphyxiated condition, but was brought back to life only to die ten days later.

The second case was that of a foetus of four months, that had been injected from the abdominal aorta.

As you see from the sketches which I have submitted to you, these villi bear the greatest resemblance to those of the intestines. They appear, however, both in their position as well as in their numbers to confine themselves to a particular locality: topographically, because they are never found in cross-sections (through the *Mt*, handle of the hammer, and neighboring tympanic wall) made below the superior third of the handle of the hammer; numerically, because we rarely meet with more than eight. They rest upon the inner tympanic wall opposite the posterior periphery of the *Mt*, but on this side of the locality where the fibres of the membrane are inserted into the annulus tympanicus. They look somewhat like a finger, and measure about 0.2 *mm.* in length and 0.055 in breadth. They are evidently prolongations or protrusions of the mucous membrane, are composed of the narrow edge of the same, are covered with a single layer of ciliated cylinder-epithelium, and bear within them a *single* vascular loop—at least I have never seen more than one, although Gerlach speaks of several vascular loops in the villi of the mucous layer of the membrana tympani. These loops arise from the vessels of the mucous tissue which underlies the mucous membrane, and is, at this time, as is easily to be understood, still extraordinarily increased in thickness. From the location at which the villi cease to appear, the mucous membrane continues to bear for some distance a wavy and almost papilla-like appearance, although I have never been able to demonstrate vessels or loops of vessels, even in injected specimens, in any of these papilla-like prominences, which, like the villi, are also covered with a ciliated cylinder-epithelium.

Further investigations must show whether the occurrence

of these villi is constant, or whether they are only present in the fœtus and new-born children, and then disappear after respiration has become well established, just in the same way as the underlying mucous tissue of the *labyrinthine wall*.

*Explanation of the Figure.*

Cross-section at the upper third of the handle of the hammer through the membrana tympani, adjacent wall of the external auditory meatus, and the mucous membrane of the inner tympanic wall in a four-months' fœtus ; injected from the abdominal artery. Hartnack, eye-piece 3, system 4, no tube.

*p*, papillæ of the cutis of the external auditory meatus, which cease close to the membrana tympani.

*t*, membrana tympani with a few vessels in the cuticular layer and mucous layer, a few of these being empty, the others filled with the injected substance. A large oval vascular cavity lies just at the boundary line between the *Mt* and the mucous membrane of the internal tympanic wall.

*z*, the villi (a few with an injected vascular loop) resting upon the mucous tissue, which exhibits a large number of vascular cavities.

## ON THE STRUCTURE OF AURAL POLYPI.

BY DR. J. B. WEYDNER, MUNICH.

Translated by Dr. J. A. SPALDING, Portland, Maine.

THE study of aural polypi is of great and interesting assistance to us in our investigations into the nature and origin of tumors in general, because in cases of polypus of the ear we have the most favorable opportunities of examining them in all stages of their growth. In a word, the cause of their origin and the manner of their development lie clear before our eyes. Although Moos and Steinbrügge have lately published a long and interesting paper upon this same subject,<sup>1</sup> yet I see no reason why I should not again offer for the consideration of the profession another long series of examinations of polypi, and so much the more reasonably as I am able to append the clinical history of almost every case.

The great majority of aural polypi spring from the soil afforded by a suppurative inflammation of the middle ear in the shape of small round granulations, which possess all of the histological peculiarities of the common kind of wound granulations; exceptionally, however, they exhibit an epithelium which often takes an enormous share in the growth of the polypus. If we examine aural polypi of older growth we see again, just as in granulations after wounds or incisions, that, even when the granulation-tissue is still present, there are various mixed forms, intermediate between true granulation-tissue and mature connective tissue. The older the polypus the greater the amount of con-

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<sup>1</sup> These ARCHIVES, vol. xi., p. 328.

nective tissue. Nevertheless, even in the oldest polypi we discover clumps and clusters of round cells, particularly in the periphery. If the middle ear is entirely free from supuration at the time of examination we can frequently demonstrate the presence of some equally sufficient local irritation, such as a foreign body which presses upon the walls of the auditory meatus, or a plug of cerumen which has remained for a long period within the meatus, or has been pushed even deeper in or down upon the membrana tympani by the patient himself.

Hence, I think myself justified in asserting, from the microscopic as well as the clinical picture, *that almost all aural polypi are originally nothing but granulation-tumors*, whose fate it is to be ultimately transformed into connective tissue. For this reason I shall all the more carefully describe as a whole, and in the closer details, the microscopic condition of all the aural polypi that I have so far seen. Only a few of the polypi attain, however, any considerable size, and undergo the above described transformation. For, leaving aside the large number of polypi which are operatively removed at an early date, others are by no means infrequently spontaneously exfoliated by the accidental rupture of the pedicle, especially when it is fragile, as we frequently see a polypus dislodged from the meatus by a single syringeful of water, though gently applied. Then, again, many polypi do not appear to have any tendency to increase in size after attaining certain dimensions. Sometimes, also, spontaneous involution takes place when the exciting cause has been removed, a fact of which we shall surely be convinced after removing sequestra which have become imbedded in polypoid proliferations. This process can be aided and supported by the alcohol treatment, and by antiseptics. The chief reason why we so rarely meet with large aural polypi with mature tissues is that the processes of nutrition within the polypus have in some manner been disturbed or absolutely prevented. Thus, in most polypi, even in those that are still minute, we may find partial degeneration of the tissues, and, as a cause for the same, extensive alterations in the vessels.

The chief histological characteristic of aural polypi is the preponderance of granulation-tissue: large round cells with large nuclei and innumerable nucleoli lying within a delicate alveolar frame-work. These cells lie close together without any considerable amount of intermediate substance. The older polypi exhibit in addition regular rows of nuclei like these, mingled with spindle-shaped cells and more or less mature connective tissue; the older the polypus the more abundant the connective tissue. The transformation of connective tissue begins chiefly in the axis of the tumor, from the root outward. Round cells are in most cases found in the periphery. The external layers of young polypi, especially, exhibit smaller round cells lying together in pairs or triplets, or even in larger numbers, or else large ovoid, elongated cells, constricted in the middle, suggesting to the observer the peripheral growth of the polypus by segmentation of cells. Alongside of these normal cells, however, the tissue is often found in a very degenerated condition. We observe, amongst other changes, a more or less extensive œdema with increase of the intermediate substance, a dust-like opacity of the same tissue, and myxomatous degeneration. The nuclei themselves are swollen to such a degree and are so opaque that the nucleoli can no longer be recognized. Moreover, we frequently find hemorrhagic infarctus with its sequences, in which the alveolar frame-work is still preserved and filled with red corpuscles, or deposits of pigment cells, which in this case are mostly taken up by the round cells. Giant-cells are also generally visible amidst incipient degenerative changes like these.

The cause of all these occurrences is to be sought for alone in the blood-vessels, which in the youngest polypi form a thick network of capillaries, precisely as in simple granulations. The larger vessels have either very thin walls, in which case they are extremely varicose, or enormously thickened walls which occasionally exhibit hyaline degeneration. Besides this, many of the vessels are filled with thrombi. Three of the polypi that I examined consisted almost entirely of vessels and cavernous spaces (angioma).

Only two thirds of all aural polypi possess an epithelium.

Those which have no such external covering, are usually small roundish tumors with a smooth surface composed of a thicker tissue. It is difficult to decide whether the epithelial layer was only destroyed at a later date by the corroding influence of the secretion (a circumstance frequently observed in other parts of the body), or whether the tumor sprang from a region which had previously been deprived of its epithelium. Whenever the epithelium is found upon the polypus, it corresponds of course to the epithelium of the soil from which the polypus arose, so that polypi which spring originally from the tympanic cavity are covered in the beginning at least, with a layer of cylinder-epithelium, while those that spring from the meatus are covered with a layer of pavement-epithelium. There will of course be exceptions in the case of polypi of greater than the average size, for, on the one hand, in some of those which without any doubt must have originated in the tympanum we find that the base alone is covered for a greater or less extent with cylinder-epithelium, while the summit is provided with pavement-epithelium. Between these varieties we find occasionally a cubical epithelium with one or more layers. On the other hand, I have found a large number of polypi whose roots, after removal of the tumor itself, were seen growing within the limits of the external meatus (although indeed at its inmost end), but which were partially and, in some instances, completely covered with a cylinder-epithelium. It is possible in these cases, in contradistinction to those previously mentioned, that the pavement-epithelium was transformed into cylinder-epithelium, which we may perhaps interpret by suggesting that the cylindrical basal layer was all that remained of the pavement-epithelium. Still, no other observations on this point have yet been published. I have not seen upon any of the polypi under notice a pavement-epithelium with vibrating cilia. The polypi which spring from the cuticular layer of the *Mt* are characterized by the long palisade-shaped processes of the rete Malpighi, sinking deeply into the fundamental tissue, as well as by the broad band-shaped fibres of the tunica propria, as V. Tröltsch first described

them. The numerous furrows and papillæ on the surface of the polypi cause us to find in many of the sections moderately deep indentations into the substance of the tumor, while further in we see round cavities lined with cylinder-epithelium, which former observers used to describe as the glands of polypi. I have never been able to discover any indentations which could accurately be compared to a tubular gland, and I think that the explanation just offered suffices for all of these appearances. When these folds and papillæ lie close to one another, the epithelial layer at the point of contact is gradually destroyed by pressure, so that the walls insensibly and mutually coalesce. In the bottom of the furrow, which is generally somewhat spacious, the epithelium is still preserved intact, and a genuine, strangulated, round, gland-like cavity is thus formed, lined with cylinder-epithelium, or filled with a pearl of epidermis. Transudation frequently takes place into this cavity; the transudate coagulates and the epithelium is gradually destroyed. In many cases, however, we find remnants of the epithelium that have been preserved, and it is by these that we can easily determine the correct significance of these cavities. The sheaths of the hair bulbs also frequently appear to be the starting points for circumscribed proliferations, for in polypi I have often found imbedded larger or smaller pearls of epidermis and cholesteatoma, sections of which exhibited bits of hair and long fissure-like spaces which probably had contained cholesterine crystals—the latter having dissolved in the alcohol. The most interesting of all the polypi was one which consisted only of proliferated sebaceous glands with slight supporting tissue (adenoma).

Before describing the various polypi and giving a brief abstract of the clinical history of the cases, I have one or two additional remarks to make.

All of the polypi which were not dislodged by the force of the current from the syringe were removed with Wilde's snare. One polypus only was crushed off with the surgical forceps. The after-treatment consisted in cauterization of the stump with argentic nitrate fused upon the end of a



probe, or with chromic acid in crystals, and when the hemorrhage was excessive, by sopping the stump with a solution of ferric perchloride. The boric-acid treatment, as suggested by Dr. Bezold in 1878, was then persisted in until all supuration had entirely ceased. Further, I would state that where I have mentioned the dimensions of the polypi, I had only before me those tumors which had lain, perhaps for years, in alcohol, and were as a matter of course enormously shrivelled, while the dimensions given in the clinical histories were discovered directly after the removal of the tumor. Finally, I would remark that the watch, with which tests of hearing were made in many of the cases, could be heard normally at four feet.

In order to compare the polypi more satisfactorily with one another, I have arranged them according to the clinical picture. First, those which sprang up during the course of an *otitis media purulenta ACUTA* upon the *Mt* and in the *auditory meatus*, generally during the period of observation. These consequently exhibit the earliest stages of development. Secondly, those which were discovered in the tympanum or on the *Mt* and in the meatus during *otitis media suppurativa CHRONICA*, in which class those with simultaneous perforation of Shrapnell's membrane are arranged by themselves, on account of the peculiarity of the process there involved. Finally we have those polypi which originated in the external auditory meatus from any given local irritation.

#### FORMATION OF POLYPI IN:

##### I.—*Otitis media purulenta acuta.*

##### *a : On the membrana tympani.*

CASE I.—Mr. F., æt. fifty-nine. February 16, 1880. Otorrhœa, left ear, four weeks; began with violent pain. Watch = 0. The air douche presses pus out from a flat tumor on the posterior half of the *Mt*; no perforation-whistle, yet watch is at once heard on contact. Profuse suppuration lasts for two months despite antiseptic treatment. April 11th, the tumor was snared off; a fortnight later pain, tenderness, and swelling over the mastoid region. Pressure on the most sensitive spot forces an abundance of pus out from the meatus. Wilde's incision, and a sound passed 3.2

into the opening. No distinct communication with the tympanum. The fluid in the incision-track pulsates freely. May 10th, suppuration from the meatus has ceased, and that in the incision is trifling. The perforation in the *Mt* soon healed over, and the opening behind the ear completely closed by May 27th. The hearing was subsequently improved, by use of catheter, to watch, 2' and by December to 5'.

The polypus is as large as the head of a pin, covered with pointed papillæ and a thin layer of pavement-epithelium, and consists of minute round cells lying in a peculiar alveolar tissue. The intermediate substance, thickened at the periphery, is opaque as if dusted over; vessels scarce.

CASE 2.—Mr. F., æt. forty-seven. April 25, 1880. Four weeks ago violent pain in the head and previously healthy right ear; discharge ever since. Mastoid process sensitive to the touch. Right: hearing, loud voice, 3'. Perforation-whistle. *Mt* apparently bulged forward polypus-like in its upper portion. The left meatus shows an exostosis just over the short process and directly in front of the *Mt*. Watch at 2'. April 27th, polypus on the *Mt* removed. May 5th, having re-appeared it is again snared off. During this time continuous pain in the mastoid. June 24th, a third polypus removed from the same position, and its base cauterized with chromic acid in substance. The discharge ceased by July 4th. The perforation in *Mt* closed over, and by August 1st, hearing was 3' for a whisper.

One of the three polypi only was examined. It shows an enormously thick pavement-epithelium, closely compressed round cells with a few spindle-shaped cells; vessels difficult to find.

CASE 3.—Mr. H., æt. forty-two. May 3, 1881.—Unilateral acute suppuration of the middle ear; polypus in the posterior superior quadrant of the *Mt* removed and the base cauterized with liquor ferri. Frequent paracentesis necessary to prevent too rapid closure. June 12th, the suppuration has ceased and the *Mt* is permanently closed; watch, 2½'.

Small polypus with very thick pavement-epithelium composed of extremely degenerated and œdematous granulation-tissue. Some of the few blood-vessels show thrombosis.

CASE 4.—Anna R., æt. five, totally deaf in both ears; discharge without pain for seven weeks following scarlatina and diphtheria. Both meatuses filled with polypi; November 16th, polypi removed

from both sides ; total loss of *Mtt.* Treatment was declined ; patient neglected, and returned after several months with fetid suppuration in both ears ; no relapse of the polypi. The suppuration ceased under the boric-acid and iodoform treatment ; deaf-mutism.

Medium-sized polypus with thick pavement-epithelium, large round cells, and interspersed with numerous wide lymph-spaces.

CASE 5.—Mr. T., æt. twenty-nine. February 10, 1883. Acute suppuration of the left ear for five weeks, with fever and pain in head ; suppuration very profuse and extremely offensive ; hearing, low voice, 10 *cm.* ; perforation sound ; pain on pressure on the mastoid. The seat of the *Mt* is occupied by a broad polypus ; removed on March 2d. By March 8th a new polypus made its appearance in the same spot and was snared off. The same on March 17th, 24th, and April 15th. The suppuration continued till June 30th, when the perforation closed, and low voice could be heard at 1 *m.* July 15th, hearing 1½ *m.* The *Mt* appears normal.

Flat polypus as large as a pea, without epithelium ; consists of round cells with increased opaque intermediate substance, numerous blood-vessels, and cavernous base.

*b : In the external meatus.*

CASE 6.—Mr. K., æt. forty-three. February 10, 1881. Acute middle-ear suppuration for a fortnight. The meatus is so narrow that the *Mt* can scarcely be seen. Suppuration profuse but inodorous. Hearing, low voice, 40 *cm.* The suppuration persists despite boric-acid treatment. A polypus on the posterior wall of the meatus is snared off. The suppuration ceases July 9th ; *Mt* closed over ; whisper, 5 *m.* ; watch, 10 *cm.*

The polypus is flat, has a broad base, no epithelium, is made up of degenerated round cells transformed into clods, in which we can no longer recognize the nuclei ; numerous vessels with very thick walls and many thrombi ; hemorrhagic infarcti.

CASE 7.—Mr. P., æt. twenty-eight. February 5, 1882. Deafness in the right ear since infancy. Six weeks ago pain in right ear, followed by profuse otorrhœa ; intense pain in the head. The cartilaginous meatus is filled with a polypus covered with epidermis, the removal of which is accompanied with a gritting sound. The stump is cauterized with liquor ferri. Total deafness, right. The orifice was slightly dilated with laminaria bougies.

The polypus is ovoid, as large as a pea, and has a broad base. It is composed of pavement-epithelium, with enormous development of the rete Malpighi, a few round cells with nuclei, and near the base some connective tissue. Vessels scanty, though the root is very vascular.

*c : Within Wilde's incision.*

CASE 8.—Acute granulations in Wilde's incision.

Kidney-shaped polypus 1 cm. long, without epithelium, composed of round cells, numerous vessels, several of which contain thrombi, at which places the intermediate substance is increased and opaque. Occasionally a few spindle-shaped cells.

II.—Otitis media purulenta chronica.

1.—Simple.

*a : Polypi of the tympanum.*

CASE 9.—Master H., æt. fourteen. June 14, 1883. Otorrhœa, right side, for two months ; at first with pain. Three weeks ago the mother noticed something growing from the meatus ; this is snared off under chloroform, the base touched with liquor ferri. The root lay on the floor of the tympanum. July 27th, both ears dry ; right ear, large perforation of *Mt*, the round window visible in profile. A small granulation is still present in the tympanum, but it does not secrete ; perforation sound.

The polypus is as large as a bean, without epithelium ; round cells with œdematous intermediate substance. A broad band of spindle-shaped cells and mature connective tissue extends from the base of the polypus. Here also we find a large space filled with red blood corpuscles ; also hemorrhages in the tissue.

CASE 10.—Miss W., æt. thirteen. July 17. 1883. Discharge from the left ear for four years, and repeated removal of polypi ; cause scarlatina ; suppuration with headache ; July 18th, removal of polypus ; July 21st, another portion resting upon the deepest part of the meatus and probably on the posterior wall of the tympanum was snared off ; *Mt* absent ; perforation-whistle. Up to September 2d suppuration had not returned.

Bean-sized polypus, with narrow vascular root and coarse lobules. Cylinder-epithelium at the base, pavement-epithelium elsewhere. The whole polypus is interspersed with hemorrhages, partly necrosed, and shows faint traces of connective tissue and round cells.

CASE 11.—Miss H., æt. twenty-two. March 28, 1883. Otorrhœa six years; right with perforation, left with polypi filling the entire meatus. Hearing, low voice, right 80 *cm.*, left 20 *cm.* Perforation sound on both sides. The polypus is snared off and the root, which rests in the tympanum, cauterized with chromic acid. Up to April 28th both tympanic cavities are dry. Hearing for low voice, 5 *m.* right ear, 2 *m.* left ear.

Polypus larger than a bean, with distinct root and deep furrows. On the bottom, cylinder-epithelium; on the summit, pavement-epithelium. Large vessels, imbedded in a wavy connective tissue, extend from the cavernous root to the summit of the polypus. Round cells lie just beneath the surface. Numerous and extensive hemorrhages.

CASE 12.—Mr. E., æt. twelve. April 8, 1878. Otorrhœa, five years, on both sides. Right ear, large tympanic polypus in the lower half of the tympanum; left ear, granulations upon the margin of the *Mt.*, and tympanic mucous membrane swollen. Hearing for low voice 2 to 3 *m.* on both sides. Perforation-whistle on both sides after Politzer's inflation. April 12th, polypus removed from the right ear; left ear, argentic nitrate in substance. April 24th, last visit, the discharge had entirely disappeared from both ears.

Flat polypus, in the shape of half an egg,  $\frac{3}{4}$  *cm.* in length,  $\frac{1}{2}$  *cm.* broad, 2 *mm.* thick, covered with fine papillæ, has cylinder-epithelium near the base and pavement at the summit, and is made up of round cells with a few vessels. Myxomatous degeneration at the base very extensive, with delicate net-shaped figures of coagulation, and a few spindle-shaped and star-shaped cells.

CASE 13.—Mr. G., æt. thirty-eight. June 10, 1879. Right ear, tympanic polypus filling the osseous meatus; suppuration for fifteen years. After snaring off we see that the root of the polypus passes further backward into the tympanum through a perforation which exists in the inferior half of the tympanum. The discharge ceased in a few days, and in the summer of 1880 it was still absent.

Polypus as large as a pea, with a rough surface, has cylinder-epithelium on the base and cubical epithelium on the body, and is made up of large swollen and partly pigmented round cells in which we can discover only a few nuclei. Vessels are scarce. Some portions have been transformed into myxomatous tissue, and exhibit star-shaped cells. Ripe connective tissue is visible at the base of the tumor, as well as the characteristic broad fibres of the

tunica propria of the *Mt*, so that it is probable that a part of the root of the polypus at least had originally started from the inner surface of the *Mt*.

CASE 14.—Miss K., æt. twenty-four. October 17, 1883. Chronic suppuration from the right ear for thirteen years; at times very fetid. Raspberry-like polypus in the osseous meatus arising from the posterior superior quadrant of the *Mt*, as is evident after its removal. The *Mt* is apparently preserved *in toto*, yet is united with the inner wall of the tympanum. The posterior margin of the former perforation stands free in front of the narrow root which arises from near the stapes. Tinnitus is perceived on cauterizing the root with argentic nitrate. No perforation sound. The patient did not remain for perfect cure.

The polypus is as large as a split pea, looks like a wart, is covered at its base with cylinder-epithelium, higher up with a many-layered cubic epithelium, and is composed chiefly of round cells, although mature connective tissue, myxomatous tissue, and transition stages are also visible. The vessels are few; larger or smaller cavities empty or filled with amorphous contents and lined with flat cells—probably lymph spaces.

CASE 15.—Mrs. W., æt. thirty-seven. March 17, 1880. Discharge from both ears since youth; polypus in the right osseous meatus; left ear shows the remains of chronic suppuration.

Long round polypus, with cylinder-epithelium and vibrating ciliæ at the base, cubical epithelium at the summit. It is composed of round cells with numerous vessels, near the larger of which is some slightly œdematous connective tissue. There are also some cavities partly lined with cylinder-epithelium, and partly, instead of the latter, filled with amorphous contents, the latter evidently indentations in the epithelium which have been cut off, and followed by secondary degeneration of the epithelial cells.

CASE 16.—Mr. R., æt. twenty-eight. June 18, 1879. Occasional otorrhœa since youth. In 1872 he suffered for a long time and almost daily from violent attacks of vertigo with tendency to vomiting. The discharge was at that time dark and continuous. He has had renewed discharge, vertigo, and headache for six weeks. The inner half of the left meatus is filled with a polypus which is snared off three times in succession. The root lies in the tympanum. Total destruction of *Mt*; suppuration soon ceases.

Three bean-like tumors, one of which is examined. It has

cylinder-epithelium on its base, but the largest part of the surface is covered with pavement-epithelium, and is composed chiefly of mature connective tissue with myxomatous patches. Round cells scattered here and there on the surface and in the interior ; a few vessels.

CASE 17.—Dr. S., æt. twenty-seven. Suppuration of left ear for three years. Polypi have been repeatedly removed by other otologists ; one apparently filling the whole meatus is snared off at once. The suppuration ceased in a few days and has remained so since. *Mt* almost destroyed.

Large oval polypus with a thick pavement-epithelium, which has pushed long, narrow prolongations into the polypus. The polypus is composed of very large, round cells, with numerous vessels full of thrombi. A thick cord of broad-fibred connective tissue with long, narrow nuclei extends from the base outward. The connective tissue is almost mature. The whole tissue shows excessive degeneration as well as numerous hemorrhages.

CASE 18.—Mrs. H., æt. twenty-five, January 4, 1882. Otorrhœa on both sides since infancy. Left ear : a polypus extends about 1 *cm.* beyond the meatus, and is red and glittering. No pain, vertigo, or tinnitus. The use of the snare meets with great resistance on the part of the polypus. Hearing, low voice,  $\frac{1}{4}$ '. January 7th, the remainder is snared off, and the rest syringed out. The base of the polypus lies in the tympanum ; perforation of *Mt*, down and in ; perforation-whistle. January 12th, suppuration has ceased ; hearing, low voice, 3'.

Polypus 2 *cm.* long and  $\frac{3}{4}$  *cm.* thick, covered with small papillæ. At the base cylinder-epithelium, further up pavement-epithelium. Granulation-tissue, which in the middle is œdematous, and under the surface gives way to numerous narrow fibres of connective tissue ; wide vessels with thin walls.

CASE 19.—Mr. M., æt. nineteen. July 3, 1879. Chronic suppuration in both ears since childhood. Last evening profuse hemorrhage from the left ear. A dirty blackish polypus deep in the meatus, and completely filling it, is snared off. Watch, on contact. Inco-stapedial joint visible in the perforation ; *Mt* has united with the long arm of the anvil, but on being separated by the curved needle, watch is heard at one inch and a half. August 3d, watch at two and a half inches. The secretion has ceased.

Polypus, as large as a cherry, with villi on the base. No epithelium; its place occupied by coarse fibres and increased accumulation of cells. *The body of the tumor consists wholly of wide and narrow vessels with thin walls, while between them lie cavities filled with red blood corpuscles.* The vessels are extremely wide at the base, and decrease in size toward the summit where they are extremely fine. Round cells predominate, and are interspersed with a few giant-cells.

CASE 20.—Master H., æt. fourteen. September 14, 1883. Chronic suppuration for five years with polypus, fetor, occasional hemorrhage, but no pain. Polypus removed. Hearing, low voice, 10 cm.; no perforation-whistle. The polypus sprang from the posterior wall of tympanum. *Mt* shows sickle-shaped perforation in the upper quadrant, through which can be seen the promontory covered with granulations. The handle of the hammer is apparently necrotic, and is removed despite adhesions. September 24th, the suppuration has ceased. The *Mt* appears as if the handle of the hammer were still in position, but this arises probably from the cartilaginous portion of the hammer having remained behind; most of the mucous membrane of the tympanum has been transformed into epidermis. Hearing, low voice, 10 cm.; after insufflation of pulverized boric acid, hearing, 30 cm.

Polypus: pure granulation tumor, the size of a pea, consisting only of round cells with large vessels.

The handle of the hammer can be easily cut without previous decalcification; cross-sections are perfect. It is covered with pavement-epithelium, but its osseous substance has been replaced by connective tissue rich in cells, containing hemorrhagic and myxomatous patches. A few bits of cartilage are still recognizable.

CASE 21.—Mr. R., æt. forty-two. May 7, 1878. Right-ear polypus in the meatus, probably emerging through a perforation in *Mt*, due to too energetic syringing ten years before. Profuse suppuration for four years. After snaring, watch on contact (?). May 19th, a second polypus snared off. July 4th, the discharge has ceased; hearing, watch, 1 inch.

The first polypus is about 1 cm. in length, very slender and with a club-shaped end. Most of the surface shows cylinder-epithelium; at the end, cubical epithelium. A band of connective tissue with large vessels, embraced by a thick covering of round cells, passes entirely through the axis of the polypus.



The second polypus is round, the size of a split pea ; cylinder-epithelium, round cells, and many large vessels.

CASE 22.—Miss R., æt. twenty-four. July 6, 1876. The patient accidentally dropped some muriatic acid into her ear, five years ago. Suppuration, two years ago; persistent pain for six months. Since then continuous otorrhœa. Tuning-fork is heard in this ear (*which ear?*—TRANS.) at one inch. Polypus springing from the tympanum snared off. The base is touched with liquor ferri. Perforation-whistle. Injected fluid runs through the nose—at a later visit there was no discharge.

Of the bits of polypus, one is about 1 *cm.* in length, covered at the base with villi and composed of round cells with varicose vessels ; most of the surface is covered with cylinder-epithelium with vibrating cilia ; at the summit, cubical epithelium. Œdema and hemorrhagic infarctus. The second portion is oblong ; base has pavement-epithelium ; round cells abound, mixed with spindle-shaped cells and mature connective tissue.

CASE 23.—Miss K., æt. twenty-four. October 1, 1883. Chronic otorrhœa *after scarlatina* at the age of six. Discharge more profuse for two months. *The syringe dislodges* a pea-like polypus with slight hemorrhage, apparently from the upper part of the tympanum. October 6th, no discharge ; perforation-whistle.

Polypus : no epithelium ; round cells, which on the periphery are small and degenerated. At the base, giant-cells. In the centre, several large vessels ; all the rest are small.

CASE 24.—Caroline R., æt. three. Jan. 25, 1881. Otorrhœa one year, left side, *after scarlatina*. Polypus on promontory. The ear had been syringed for months with carbolic-acid lotions. Snaring.

Round tumor without epithelium, very vascular, particularly in the middle. The component round cells are degenerated in the margin of polypus.

CASE 25.—Master V., æt. fourteen. October 13, 1876. Chronic otorrhœa and perforation of *Mt* on both sides for six years, subsequent to *scarlatina*. The polypi originate close to the *Mt*, and perhaps in the tympanum. Hearing, low voice, both ears, 2 *m.* October 14th. Polypi in the right ear removed ; hearing increased to 5 *m.* Argentic nitrate to base. Up to December 20th no discharge.

Small lobulated polypus : on the base cylinder-epithelium,

further up pavement-epithelium ; round cells. At the periphery, the intercellular substance is increased ; a few spindle-shaped cells.

CASE 26.—Master A., æt. ten. Six years ago *scarlatina*, followed by continuous otorrhœa on both sides. In the right meatus, a polypus  $2\frac{5}{8}$  cm. long. Snare. Liquor ferri.

One of the large fragments was examined ; ciliated epithelium, then cubical, and lastly pavement-epithelium. Myxomatous connective tissue everywhere except directly beneath the surface, where spindle-shaped and round cells are present. Large, thin-walled vessels at the base. Numerous large cavities partly lined with cylindrical epithelium, partly enclosing fragments of the same or amorphous contents, or even quite empty, so that we assume that all originated in the same way, viz., by folding in of the epithelium.

CASE 27.—Anna, æt. five. May 18, 1881. *Scarlatina* a year and nine months ago, followed by offensive otorrhœa, left, ever since. Deep in the meatus a soft polypus. Snared off. Chromic acid. The suppuration ceased at once.

Semi-globular polypus the size of a pea ; pavement-epithelium, pushing its palisade-like processes into the tissue, composed of large round cells with a few varicose vessels.

CASE 28.—Master H., æt. fourteen. June 30, 1879. Eight years ago *diphtheritis*, followed by otorrhœa left side. Polypus removed *with the syringe*. Discharge cured.

Cherry-sized polypus : no epithelium ; round cells, traversed by spindle-shaped cells in all directions. Hyaline degeneration of the vascular walls.

CASE 29.—Mrs. H., æt. nineteen. November 17, 1881. For four years repeated otorrhœa, right side. One year ago repeated hemorrhages. During the last few weeks occasional pain for a day or two at a time. Hearing, low voice, three inches. Polypus snared from the *Mt* or the promontory, followed by remission of pain. A small polypus still remains. November 19th. Violent headache last night. Syringe removes cheesy fragments and clumps of epidermis. November 20th. The small polypus snared off. No perforation-whistle. December 7th. Discharge has ceased, posterior half of *Mt* destroyed ; mucous membrane of the tympanic walls transformed into epidermis. A small perforation above the short process is surrounded by a margin of epidermis, which was

the situation of the second polypus. Hearing, low voice, four inches. December 28th, no discharge. Hearing, low voice, eight inches.

Both polypi are composed of closely aggregated round cells, with numerous large vessels; no epithelium; giant-cells in the larger polypus.

CASE 30.—*Polypus dislodged after using the syringe*, probably from the middle ear.

Small tumor without epithelium, degenerated round cells, abundant pigmentation, and a few wide vessels. A few giant-cells at the base.

CASE 31.—Master G., æt. fifteen; April 12, 1882. Chronic otorrhœa, left side, since infancy; a polypus had been removed two years before. A new polypus now projects beyond the orifice of the meatus, and is removed at several sessions. Result unknown.

Large polypus: no epithelium, a few spindle-shaped cells in the middle, and mature connective tissue—especially at the base. Surrounding the whole, a mantle of round cells; numerous hemorrhages and extensive degeneration; a few small vessels.

CASE 32.—Fanny, æt. five. Chronic otorrhœa, left side. Repeated snaring off of polypi; once a polypus *was dislodged with the syringe*. No constitutional affection, despite acute local inflammatory symptoms. The child died several months later, at the General Hospital, with cerebral symptoms.

*Autopsy*.—Cholesteatoma in the tympanum and antrum, rupture of tegmen tympani, meningitis, and cerebral abscess.

Polypus as large as a bean, coarsely lobulated, thin pavement-epithelium, round cells, and numerous vessels, a part of which show thromboses. Occasional spindle cells and mature connective tissue.

CASE 33.—Polypus removed with common surgical forceps.

Polypus as large as a hazel-nut, with coarse lobes, and a pavement-epithelium with extraordinary development of the rete Malpighi. Fibrillar, wavy connective tissue, with spindle-shaped and scattered, large round or oval nuclei—easily distinguished from the cells of the granulation-tissue. Beneath the surface, groups of round cells and a few myxomatous patches. Furthermore, large cavities, partly empty, partly lined with cylinder-epithelium, originating as before suggested. Small vessels, with thickened walls and numerous thrombi.

*b : Polypi of the membrana tympani.*

CASE 34.—Mr. M., æt. thirty-three. March 29, 1882. Otorrhœa from both sides occasionally since childhood ; lower half of *Mt* absent. The polypus in the right ear appeared to rest upon the short process and handle of the hammer, for a gritting sound was perceived as the snare tightened, and a bare patch of bone could be felt with the probe. Slight hemorrhage ; argentic nitrate. Hearing for low voice : right, one foot ; left, eighteen inches. Perforation-whistle on both sides. May 19th, hearing for low voice : right, eight feet ; left, six feet. Discharge ceased.

Round polypus : no epithelium ; round cells with few vessels ; giant-cells. Laterally the sections show a semicircular piece of bone (handle of hammer), with large medullary cavity, cartilaginous envelope and remains of the *Mt*.

CASE 35.—Master W., æt. nine. November 23, 1879. Otorrhœa since dentition ; in March last, pain in left ear and abscess behind the auricle, demanding the use of the knife. Extensive perforations of both *Mt*. Continuous suppuration, with occasional hemorrhage. Polypus partly destroyed with galvano-cautery, but suppuration continues.

The first polypus has no epithelium ; composed of round cells, many segmented at the periphery, arranged in rows, and mingled with spindle-shaped cells. Most of the vessels have thick walls ; a few have thrombi.

The second polypus envelops the entire handle of the hammer, after removal of which the following condition is discovered : thick epithelium with long processes ; connective tissue interspersed with round cells ; broad ribbon-like fibres of the tunica propria of the *Mt*, and a portion of the cartilage of the handle of the hammer.

CASE 36.—Master K., æt. nine. December 31, 1883. Five years ago, diphtheria, followed by chronic otorrhœa, left side, with polypus on *Mt* ; profuse discharge running down on shoulder. Tuning-fork by aerial conduction ; low voice at 5 *cm*. *Mt* covered with a polypus, which is snared off January 5th, bringing with it the entire hammer, partially necrosed. Hearing, 20 *cm*. January 10th, the rest of the polypus is removed. The fetid suppuration still persists to this day, despite the frequent irrigation, the use of astringents and antiseptics—boric acid, peroxide of hydrogen, and a five-per-cent. solution of carbolic acid. *A few*

*tubercle bacilli discovered in the aural secretion, but there are no demonstrable defects in the lungs as yet.*

A polypus with a triangular piece of bone in its centre. The perichondrium extends in to the tunica propria of the *Mt*, and then into the tissue of the polypus, where it finally disappears. The tumor consists of round cells, thick pavement-epithelium, and extensive rete Malpighi sending long prolongations into the tissue of the polypus.

CASE 37.—Miss K., æt. twenty-one. *Scarlatina* twelve years ago, and persistent otorrhœa on both sides ever since. Small polypi around the perforation in right *Mt*. Left ear, a polypus lying on the floor of the osseus meatus ; snared off. The tumor rests on the margin of the opening in the *Mt*, and arises from the *Mt* itself.

Polypus :  $\frac{1}{2}$  cm. long,  $\frac{1}{4}$  cm. thick. The cylindrical-epithelium at the base soon changes into cubical. Round cells pushed aside occasionally by the intermediate substance. Spindle-shaped cells and a little mature connective tissue.

CASE 38.—Mrs. H., æt. forty-two. October 17, 1883. Otorrhœa, left side, for *forty-one years*, with tumor on the perforation-margin of *Mt*. Hearing for low voice, 30 cm. *The injection dislodges* a small, pale polypus ; *Mt* almost entirely absent. November 16th, discharge has ceased.

Polypus : no epithelium, large round cells, numerous vessels with very thick walls and thrombi. Yellowish pigment, partly enclosed in round cells and partly free in the tissue ; a few giant-cells.

CASE 39.—Miss W., æt. twenty-nine. September 10, 1881. Suppuration for nine months, after repeated deafness. Left ear : Perforation of *Mt*, filled with a pale, small tumor, not protruding much beyond the level of the perforation, but which can be moved with the probe, when we discover that it is attached to the posterior periphery of the perforation. Snare ; suppuration ceases. Hearing : Watch, right ear, two inches ; left, five.

Round polypus : pavement-epithelium, here and there thicker than usual ; closely aggregated round cells, with perivascular connective tissue. The cortical layer is œdematous and myxomatous ; pigment in the round cells ; a few vessels in the middle ; in the margin, delicate capillary net-work.

CASE 40.—Mr. N., æt. sixteen. April 24, 1881. Chronic otor-

rhœa, right side. Polypus arising from the posterior margin of *Mt*; snared off. Liquor ferri. Hearing: low voice, one foot and a half. April 27th, discharge ceased, and remained so at last visit in July.

Bean-sized polypus, with small lobes; pavement-epithelium, with long processes. Round cells, with large amount of connective tissue. A few very large and very thin-walled vessels.

CASE 41.—Mr. R., æt. twenty. March 22, 1882. Otorrhœa, both sides, since age of three. A bean-shaped polypus removed from margin of perforation in *Mt*. Perforation-whistle. The supuration ceased April 13th.

Long round polypus; pavement-epithelium, with the long, thin processes characteristic of those polypi which spring from the *Mt*. Large round cells, with fibres of mature connective tissue and spindle-shaped cells. Numerous vessels.

CASE 42.—Miss S., æt. fourteen. November 21, 1883. For three months, occasional pain in left ear, fetid discharge. Perforation-whistle. Large polypus, deep in the meatus, springing either from the edge of the perforation, or from the tympanum. After this is removed a second comes to light beneath it, and is snared off. Anterior half of *Mt* lost, the rest is grayish-red and shiny. Small granulations on the inferior margin of *Mt*. Secretion still present, the case remaining under treatment.

The larger polypus: pavement-epithelium, and rete Malpighi penetrating deeply into the tissue; filled almost sieve-like with large round, thin-walled cavities, in which are red blood corpuscles (*teleangiectasis*). Broad ribbon-shaped connective-tissue fibres like those in the *Mt*, abundantly interspersed with round cells.

The second polypus is composed chiefly of pavement-epithelium, with long palisade-like processes. Round cells and smaller vascular cavities as in the first polypus.

CASE 43.—Miss H., æt. fourteen. August 4, 1881. Otorrhœa, right side, since *diphtheria* five years ago. Polypi removed from the posterior superior margin of *Mt*. Perforation-sound; hearing for low voice, three feet. August 13th, the discharge has ceased.

Cherry-sized polypus without epithelium. In the centre large, in the periphery minute, round cells, with giant-cells. Extensive hemorrhages, and partial destruction of the tissue.

CASE 44.—Miss R., æt. eleven. Otorrhœa, left side, three years,

Polypus removed with snare, but the discharge does not cease. despite boric acid, alcohol, and sodic-benzoate.

Large, long, round polypus, with pavement-epithelium, the rete Malpighi of which penetrates deeply into the tissue of the tumor. Round cells and spindle-shaped cells. Additionally a piece of the tunica propria of the *Mt*, upon which the tumor rested, has grown into the latter. Mature connective tissue and a few large vessels.

CASE 45.—Miss W., æt. seven. May 29, 1879. Chronic myringitis, right side, with granulations on the surface of the *Mt*, the result of chronic otorrhœa. Perforation-whistle. Removal of the tumor; discharge ceases August 9th.

Two of the granulations have no epithelium, but exhibit on their surfaces accumulations of fibrin and red blood corpuscles. The smaller polypus consists of degenerated round cells. Incipient connective-tissue transformation and numerous hemorrhagic infarcti, and remains of the same.

The larger polypus is composed of round cells, abundant pigment, and giant-cells.

CASE 46.—Miss Z., æt. thirty-one. October 30, 1883. Otorrhœa, both sides, chronic; the right meatus so narrow that nothing can be seen. Boric-acid treatment, followed by enlargement of meatus, and granulations visible on the *Mt*. November 8th, a small polypus removed from the *Mt*. November 13th, discharge has ceased.

Small round polypus, without epithelium, composed of round cells and numerous vessels.

*c: Polypi in the meatus.*

CASE 47.—Mr. H., æt. forty-five. September 19, 1881. Otorrhœa, right side, twenty-one years. A polypus is removed from meatus with a gritting sound. *Mt* and handle of hammer almost entirely destroyed. Tympanum full of pale granulations. Hearing absent. No vertigo. Perforation-whistle.

Polypus  $2\frac{1}{2}$  cm. long, 1 cm. thick, ninepin-shaped, with narrow root. Cylindrical epithelium, with vibrating cilia, passing over into cubical epithelium. The axis of the polypus exhibits an œdematous and hemorrhagic condition, with round cells. Numerous large cavities, with amorphous contents or homogeneous or stratified fibrin, with a few nuclei and some cylinder-epithelium. Others are lined throughout with cylinder-epithelium. The root contains large thin-walled vessels. Similar ones run in the axis of the polypus.

CASE 48.—Mr. W., æt. twenty-five. March 11, 1884. Disagreeable discharge from the right ear for fifteen years. Lately, repeated hemorrhages. A large blackish-red polypus, filling the entire meatus, is removed, and discovered to have started deep down in the meatus. A few granulations also present. No perforation-sound. March 21st, discharge reduced to a minimum; tympanic mucous membrane visible; promontory granulated. Above, the short process is just visible.

Cherry-shaped polypus, without epithelium, *consists entirely of large vessels and intervening cavernous spaces, all of which are entirely filled with red blood-corpuscles.* Around the whole are strewn some round cells, and at the base a moderate number of giant-cells.

CASE 49.—Mrs. H., æt. thirty-two. April 2, 1876. Polypi of tympanum on each side; removed. April 15, 1877, she appears once more with a polypus in the right ear, which causes headache, vertigo, and loss of memory. Snared off. Root lies at the deepest part of the meatus. The *Mt* is intact, but the handle is invisible. Watch, on contact; after inflation, four inches.

Polypus has a thin layer of epithelium, and contains small round cells, with numerous thin-walled vessels.

The smaller polypus is round, has a thin layer of epithelium at the summit, cylinder-epithelium at the vascular base, and is composed of round cells and large vessels.

CASE 50.—Mr. A., æt. twenty-two, June 11, 1883. Uninterrupted otorrhœa, left side, since infancy. Headaches frequent, and feeling of fulness in head. A polypus was removed a year ago. The meatus is now blocked up with a large polypus; removed at two sessions; springs from the end of the meatus. Hearing for low voice, 10 *cm.* June 12th, repeated snaring; liquor ferri. June 17th, snaring. The discharge now gradually decreased under boric acid and iodoform treatment.

A bit 2 *cm.* long and 1 *cm.* thick is examined; cylinder-epithelium at base, pavement-epithelium at summit. Round cells, with a few large vessels. Concentric fibres of connective tissue, and myxomatous patches.

CASE 51.—Mr. L., æt. twenty-one. March 27, 1883. Fetid discharge from right ear for eight years, but no pain; perforation-whistle. A polypus filling the meatus is snared off; liquor ferri. Hearing, watch, 10 *cm.*; low voice, 5 *m.* March 31st, the stump is again cauterized with chromic acid. May 8th, discharge has



ceased ; no perforation can be seen. Siegle's pneumatic speculum moves the entire *Mt* outward. Hearing for low voice,  $4\frac{1}{2}$  m.

Bean-sized polypus, with rough surface, composed of two parts united with a pedicle ; cylinder-epithelium at the base, pavement at the summit, wavy connective tissue interspersed with round cells. Coarse net-work of normal connective tissue interspersed with myxomatous and necrotic tissue. At the periphery, well-preserved round cells, wide, thin-walled vessels ; hemorrhagic infarctus.

CASE 52.—Mr. P., æt. fifty-one. November 2, 1883. Double otorrhœa since childhood ; right ear, polypus ; left ear, perforation of *Mt*. Polypus snared off at three sittings ; liquor ferri. Deafness, left side, for several years ; hearing in right ear variable. Large polypus in the meatus snared off. November 4th, fibrinous exudation has formed on the stump. November 7th, stump still swollen, but no discharge. November 8th, stump shrunken. November 12th, discharge ceases. Persistent perforation of *Mt* ; hearing for loud voice, 12 cm.

Polypus : cylinder-epithelium at base, pavement at summit ; composed of œdematous granulation-tissue, with numerous vessels, a number of which contain thrombi.

CASE 53.—Master U., æt. fifteen. November 16, 1882. Otorrhœa, both sides, since childhood ; polypus, right side, at age of four and eight, violent pain in right ear. Renewal of pain for a fortnight past ; facial paralysis for three days. Left, a large perforation. Right, loud voice, indistinctly ; left, low voice 50 cm. Snaring. November 25th, renewed snaring.

Very large polypus with pavement-epithelium, round cells highly degenerated, arranged in rows. Vessels numerous and containing thrombi ; a few giant-cells.

CASE 54.—Mrs. F., æt. fifty-three. May 22, 1883. Otorrhœa right side, for thirty-one years. Polypus in the meatus, perforation-whistle ; low voice doubtfully heard even close to ear, tuning-fork by aerial conduction. Frequent headache, inability to think, and weak memory. Discharge fetid. Snare. On the following day dizziness after injection, as used to be the case. May 27th, snared again. June 12th, discharge has ceased.

Oblong polypus, 1 cm., coarsely granulated surface with cylinder and pavement-epithelium. Round cells and connective tissue, also large cavities with amorphous contents. Vessels few.

CASE 55.—Mr. K., æt. twenty-four. November 13, 1882. Otor-

rhœa, right side, *since scarlatina* at the age of five. Large polypus filling the meatus, snared off several times. Liquor ferri. November 15th, fibrinous exudate in the meatus washed away with syringe. November 28th, no discharge.

Cylindrical and cubical epithelium; œdematous granulation-tissue with numerous vessels, which, just beneath the surface, form a regular net-work.

CASE 56.—Mr. H., æt. forty-three. December 8, 1876. Otorrhœa, three months, right side. Latterly pulling and roaring in the ear, Polypus snared off. Watch, one inch. December 20th, watch, three inches.

Kidney-shaped polypus 1 *cm.* long; no epithelium, and composed of closely packed, large round cells which frequently show degeneration and pigmentation. Numerous vessels with thick walls and many thrombi. Many cavities which contain an alveolar frame-work and a few nuclei, probably the remains of hemorrhagic infarctus. Small cord of connective tissue in the axis of the polypus.

CASE 57.—Mrs. G., æt. forty. July 11, 1881. From childhood to age of twenty, otorrhœa, right side; spontaneous removal of polypus. Suppuration in last five years. Large polypus in meatus, frequent headache. Hearing for loud voice three inches. Snaring and profuse hemorrhage. January 10, 1882, discharge has ceased.

Bean-shaped polypus with cylinder-epithelium at base, pavement-epithelium above. Composed of connective tissue with a few groups of round cells. At one end, extensive coagulated masses of a yellow color, in which round cells lie arranged in rows. Hemorrhagic infarctus, and cavities as in other tumors previously described.

CASE 58.—Mr. R., æt. forty-one. October 9, 1883. Has heard badly with left ear since youth. For twenty-six years has had otorrhœa on this side, and since last April pain. In May a polypus was removed; severe pain followed. For four days left facial paralysis; mastoid process sensitive to pressure; polypus in the meatus; deafness for tuning-fork by aerial conduction; right ear, normal hearing. Removal of polypus with complete relief to the patient, necrosed bone at root. October 13th, removal of polypus again. October 30th, the operation repeated, and again on November 3d, at which time three sequestra were removed,

evidently portions of the cochlea. November 4th, the rest of the polypus snared off. November 26th, the meatus is clean.

The polypus first removed is as large as a cherry, with thick epithelium, and composed chiefly of round cells, broad connective tissue at the base, vessels of narrow calibre with thickened walls.

The polypus removed November 3d is small, without epithelium and with numerous wide vessels.

The last polypus is as large as a pea, without epithelium, and consists of round cells and innumerable large vessels with intermediate deposits of pigment.

CASE 59.—Mr. S., æt. thirty-two. September 5, 1881. Otorrhœa for years on one side, from which a large polypus was removed several years ago. At present a large polypus fills the meatus; snared off and the suppuration ceases.

The polypus is oblong and has no epithelium. The stroma, composed of round cells and connective tissue, contains, in connective tissue capsules, several enormous acinous glands with distinct excretory ducts, in which we see fatty particles and around which the various acini cling. Close to the glands are bits of hair, and at one spot there is a pearl of epidermis lying across the cross-section of a hair.

#### 2.—With perforation of Shrapnell's membrane.

CASE 60.—Mr. G., æt. thirty-eight. July 18, 1877. Suppuration from left ear for four months. No pain. Right *Mt* concave. The left meatus is filled with a polypus springing from Shrapnell's membrane. Watch, on contact. Snared off, and touched base with liquor ferri. Two months later a second polypus removed from same place. January 18, 1879, no discharge; opening over short process closed; watch, on contact. June 12th, a small polypus snared off from the old locality.

First polypus the size of a cherry, round, no epithelium, round cells; numerous vessels mostly with thrombi; large groups of giant-cells, partially degenerated.

The second polypus resembles a hemp-seed; flat with vascular base, no epithelium, granulation-tissue with numerous vessels.

The last polypus is as large as a pea, horny epithelium, round cells with a few vessels.

CASE 61.—Mr. H., æt. eighteen. August 8, 1878. Discharge from right meatus for eight months; during the last two days pain in ear and head, increased upon pressure over mastoid. In the

narrow meatus a discolored polypus. Watch not heard from ear, but from mastoid and right forehead. No perforation-whistle. Polypus snared off twice, and base frequently cauterized with chromic acid in substance. The spot where the polypus rested appears to correspond to Shrapnell's membrane, and the curved sound can be pushed into a cavity leading upward. August 23d, cheesy masses syringed from the cavity. Watch, at one inch. December 23d, watch, four inches. Neck of hammer visible in perforation, but it does not feel rough.

Coarse polypus,  $\frac{1}{2}$  cm. long, thick epithelium, round cells arranged in rows at the periphery, some of which are constricted in the middle preparatory to segmentation. Occasional spindle cells. Many of the numerous vessels contain thrombi, while near by the tissue is œdematous and degenerated or else interspersed with hemorrhagic infarcti.

CASE 62.—Mr. M., æt. thirty-five. October 5, 1882. Right facial paralysis five years ago, probably from exposure. Recovery rapid. Five weeks ago the same symptom, which is still present. Otorrhœa on the same side three weeks ago without pain. In the last ten days persistent vertigo and unsteadiness in walking, and for the last two days pain. Hearing for low voice, 5 cm. No perforation-whistle. Meatus filled with a polypus, which is snared off October 6th and October 14th; chromic acid in substance. November 4th, hearing for low voice, 3 m.; slight secretion, but no perforation. At Shrapnell's membrane irregular curvature. The facial paralysis and discharge soon disappeared; hearing for low voice, 4 m.

Hemp-seed granulation without epithelium, but with large vessels; composed entirely of round cells.

CASE 63.—Mr. P., æt. twenty-five. April 1, 1880. Otorrhœa, left, for years; right, for five weeks. A polypus is removed from Shrapnell's membrane; galvano-cautery. Discharge stops April 24th. Repeated relapses and removal of polypi. At present, no discharge; large perforation near Shrapnell's membrane.

Pea-sized, pyramidal, brown polypus, without epithelium; large degenerated round cells, numerous large vessels, with hemorrhagic infarctus. Centre of polypus formed of a broad band of connective tissue; near it several cavities containing cells, probably the remnants of hemorrhagic infarctus; many giant cells.

CASE 64.—Master F., æt. sixteen. June 16, 1880. Polypus near

Shrapnell's membrane and otorrhœa left side. Snared off July 23d; and discharge ceases. Hammer and anvil plainly visible in the perforation.

Hemp-seed polypus without epithelium, composed round cells, some degenerated, others at the periphery subdividing. Numerous large vessels. At one spot the root of a hair with the appertaining sebaceous follicle.

CASE 65.—Miss M., æt. twenty-three. Double otorrhœa since childhood. April 20th, 1883, a polypus, springing from Shrapnell's membrane, was dislodged *with the syringe*. July 6th, patient returns, with pain on left side and discharge from the previously dry perforation. *The syringe again removes a small polypus from the same region.* The handle of the hammer attached to the promontory. Hearing, for low voice, 3 m., left. Suppuration ceased with removal of polypus.

Small polypus, without epithelium, round cells with many thick-walled vessels; clumps of pigment in tissue of polypus. Remains of hair follicles, sebaceous follicles, and pearls of epidermis. Giant-cells.

CASE 66.—Mrs. R., æt. twenty-six. May 8, 1883. Repeated polypi on Shrapnell's membrane. Has been subjected already to the alcohol treatment and galvano-cautery elsewhere. Within three weeks a new polypus has sprouted from the same position. Snared off. Discharge ceased in November. At present the *Mt* shows cicatricial contractions and folds. December, discharge has reappeared. January, 1884, a fresh polypus at the same locality; no perforation-sound. Operative removal of polypus as before. Hearing, low voice, 5 cm. Slight but inoffensive otorrhœa still continues.

Round polypus with excessively thick epithelium, composed of delicate myxomatous tissue, with a few round and spindle cells and numerous vessels.

CASE 67.—Mr. S., æt. twenty-one. March 12, 1882. In January, four days of pain in left ear, followed by suppuration; polypus on Shrapnell's membrane. No perforation-sound; watch, at half an inch. Patient had been treated ten years before with argentic nitrate solution, probably for suppuration. Snared off the polypus. March 21st, otorrhœa ceases; May 24th, watch, at ten inches; July 27th, no discharge.

Round polypus with cylinder- and pavement-epithelium, at the

root only ; large degenerated round cells, small amount of connective tissue, numerous ectatic blood-vessels. Pigmentation here and there in the cells, and giant-cells.

CASE 68.—Master S., æt. nine. Suppuration followed by hemorrhage from the left ear for the last twelve days. Black shiny tumor, *removed with the syringe*. The *Mt* now appears as if sunken and attached to the inner wall of tympanum. Above the short process a small perforation, with irregular edges. No perforation-sound.

At the root of the polypus a thick mesh-work of connective-tissue fibres, from which radiate other delicate fibres toward the surface, where they unite and form a thicker envelope without epithelium, in absence of which the polypus is covered with thick clusters of micrococci. The interspaces of the mesh-work are without any endothelium and filled with red blood corpuscles.

CASE 69.—Miss Z., æt. thirty. January 8, 1881. Suppuration in left ear since September, with occasional hemorrhage. In August last white scaly masses were frequently removed from the meatus. A large polypus now fills the meatus, and after snaring off, its root is plainly visible near Shrapnell's membrane. Concentric and stratified layers of skin and epidermis repeatedly evacuated after snaring off the polypus. At last the meatus is clean, and a perforation in Shrapnell's membrane is visible. Discharge ceases ; hearing for watch, two inches.

Long, roundish tumor without epithelium, composed of extensively degenerated round cells, penetrated in all directions by connective-tissue fibres, numerous vessels (especially in the periphery), and a few giant-cells.

### III.—Polypi after otitis externa.

CASE 70.—Mr. F., æt. twenty-one, April 15, 1876. Polypoid granulations on the floor of the left meatus after long-continued presence of a plug of cotton-wool. Watch, on contact. Snaring, April 30th ; no discharge ; watch, at eight inches.

Round polypus of 4 mm. diameter, without epithelium, composed chiefly of round cells with scattered hairs and pieces of epidermis. In the centre, a large piece of epidermis with an abundance of hairs. The same thing is visible toward the root.

CASE 71.—Mrs. W., æt. forty-two. July 18, 1883. Deaf for years ; plugs of cerumen in both ears, completely filling the meatus. Suppuration from the left ear for three days. *Injection*

*with the syringe dislodges* from the left ear a pea-sized, pale-red, round polypus arising from the bony meatus, but at some distance from the *Mt*; argentic nitrate to root. Both *Mt* whitish. Discharge ceases from left ear after removal of polypus. *Polypus produced by the pressure of a plug of cerumen.*

Polypus without epithelium, composed of excessively degenerated round cells and connective tissue; extensive hemorrhagic extravasations and necrosed tissue.

CASE 72.—Mr. D., æt. thirty-three. July 24, 1883. Plug of cerumen, which being removed, a small polypus with a narrow base is seen resting upon the deepest part of the posterior wall of the osseous meatus. Snared off.

Polypus is really a bit of epidermis, with concentric stratification and fissure cavities, in which cholesterine crystals were formerly situated; granules of pigment and drops of fat.

CASE 73.—*Wart from the tragus.* Bean-sized, coarsely ridged tumor, consisting chiefly of long epithelial cylinder, which extend inward from the pavement-epithelium covering the rough surface. Pearls of epidermis and very scanty supporting-tissue of connective-tissue fibres, with a few round cells and numerous vessels.

#### *Review of the above material.*

The cause of the polypi was otitis media purulenta acuta in eight cases: five of the polypi grew from the *Mt*, two from the meatus, and one from a Wilde's incision. None of these originated in the tympanum.

Otitis media purulenta chronica in sixty-one cases, in ten of which the polypus was located upon or near Shrapnell's membrane. Of the remaining fifty-one polypi, twenty-five sprang from the tympanic cavity, thirteen from the *Mt*, and thirteen from the external meatus. Besides these, there were four other cases in which polypi in the meatus arose independent of any suppuration, and chiefly, in our opinion, from the irritation caused by foreign bodies or plugs of cerumen.

Most of the patients were from twenty to thirty years of age. Ten were less than ten years of age, sixteen between ten and twenty, twenty-one between twenty and thirty, ten between thirty and forty, twelve between forty and sixty. Age unknown in four.

Forty-four of the seventy-three patients were men, twenty-seven women.

*Histologically*, thirty-three of the polypi were pure granulation-tumors, composed only of round cells and numerous vessels; twenty-three contained, additionally, some connective tissue; while in only eight polypi did mature connective tissue preponderate over the other elements. Five of the polypi were essentially vascular tumors; one a lymphangioma, one a teleangiectasia, and three cavernous angiomas, which are rare amongst aural polypi. In each of these three cases the entire tumor consisted of red blood corpuscles which lay enclosed in vessels and cavernous spaces. Consequently they bore externally a resemblance to dry clots of blood. Four of the polypi were epithelial tumors: amongst them a small cholesteatoma, which had evidently been produced in the meatus by the pressure of a plug of cerumen; a wart from the tragus; a wart-like growth from the cartilaginous meatus; and, finally, an adenoma. The last was found in a case of chronic otorrhœa, and it is interesting to see how, in this tumor, in a circumscribed space a number of sebaceous glands have enormously proliferated.

The tendency to degeneration in polypi is emphasized by our calling to attention the fact that this condition was marked in forty-six out of seventy-three polypi.

The three cases in which the handle of the hammer was partially or wholly inclosed are also very interesting. They confirm anew the assertion of Moos especially,<sup>1</sup> that it is often impossible to remove a polypus resting upon the handle of the hammer without removing the handle itself, but that at the same time the latter operation is not only not dangerous but often one of the very best steps that can be taken to abbreviate the morbid process. The myxomatous transformation of the bone of the handle of the hammer is also attractive, and reminds us of a similar case described by Hartmann in these ARCHIVES. I have never been able to discover new-formation of bone in any of the polypi that I have yet examined.

Finally, I would say that almost all of the polypi

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<sup>1</sup> *Zeitschrift für Ohrenheilkunde*, Band viii.



were hardened in alcohol or in Müller's fluid, and then on account of their diminutive size, imbedded in paraffin, or between two pieces of liver, and then microtomed. These sections were then tinted with hæmatoxylin (the best and most rapid method of tinting), cleared up in oil of cloves, and preserved in Canada balsam. Some specimens were also tinted with borax-carmin, and a number with various aniline tints, which give beautiful pictures, but they fade in time to such a degree that they are less suitable for permanent preparations.

## CONTRIBUTIONS TO THE PATHOLOGY AND PATHOLOGICAL ANATOMY OF THE EAR.

BY A. HEDINGER, of STUTTGART.

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AS a sequel to the communications which appeared last year in this journal, the following contributions to pathology and the pathological anatomy of the organ of hearing may be of interest, chiefly because the history of the disease is followed up till death, and the result of the autopsy in both cases about to be described is remarkable and somewhat rare, but also on account of the inferences to be drawn from it as regards the advisability of opening the mastoid process and the choice of the place of operation.

*I.—Papilloma in the meatus, starting from the middle ear ; suppuration of the middle ear ; burrowing abscess in the neck ; stagnation of pus ; breaking through of the pus under the dura mater, and into one of the emissaria Santorini ; opening of the cells of the mastoid process ; chiselling off its apex ; death in consequence of œdema of the brain.*

Mrs. R., aged sixty-three, first consulted me in the year 1874, on account of a discharge from the right ear. At that time the examination showed a fibrous tumor filling up the greater part of the meatus, with a net-work of blood-vessels (like a cavernous tumor) on the surface ; the discharge was moderate. Of subjective symptoms, the only one present was a feeling of numbness of the right side of the neck and face. Hearing distance, 50 cm. (normal-acoumeter). As she did not wish to undergo an operation I heard nothing from her for years. She says that within the last two years pieces of the polypus have been several times removed

by a professional hand without preventing the recurrence of the tumor. The case stood thus when, in April, 1883, she sought admission to the Ludwig Hospital, on account of severe pains in the ear. Attending these were frequent hemorrhages from the ear. At the same time there was also a purulent discharge from the ear, which, however, within the last year, had been constantly decreasing.

For several weeks she has been under treatment for severe pain in the ear, at the back of the head, and in the temporal region. She says that three days ago a swelling of the whole right temporal region suddenly appeared, accompanied by febrile symptoms. For several years she has been almost totally deaf in the right ear.

*Status præsens* : In the region of the right temporal muscle the skin is somewhat reddened, and feels warmer than the surrounding parts ; the whole region is swollen ; on palpation, springy, elastic resistance ; no distinct fluctuation. In the external auditory canal a whitish swelling is visible.

*April 23d.*—Incision through the apex of the swelling ; offensive pus is discharged from an abscess cavity which is under the temporal muscle and extends as far as the zygomatic arch ; two counter-incisions, one on a line with the zygoma, the other in front of the tragus ; the first is made under guidance of a director, the other by successive division of the several layers. A branch of the temporal artery spirts and is tied. Three drainage tubes ; cleansing with sublimate ; iodoform on the drain openings ; moist compresses (acetate of alumina).

*April 24th.*—Dressing saturated with blood and bad-smelling pus ; change of dressing ; pains have ceased ; swelling slight.

*April 25th.*—Change of dressing ; very offensive matter in the dressing and on syringing out the abscess cavity. Condition of patient good.

*May 1st.*—Daily change of dressing. Secretion continues foul. Swelling moderate. Appetite very good.

*May 4th.*—Dressing this morning completely saturated with blood. In the afternoon spontaneous hemorrhage from the anterior upper drain opening, which is arrested by digital compression.

*May 5th.*—In the evening the hemorrhage is renewed with change of dressing. Tamponing with Penghawar-Yambee.

*May 6th.*—Hemorrhage is not repeated. Patient somewhat weakened.

*May 8th.*—Removal of the tampon, which is saturated with pus and smells badly.

*May 17th.*—Strength good ; no real progress towards healing preceptible in the wound.

Patient has complained for several days of pain in the cheek opposite the first molar, where a hardness is perceptible. The swelling becomes softer and projects toward the cavity of the mouth.

Incision of abscess from without. After cutting through the skin a blunt-pointed conductor is forced into a pus cavity which is connected with the original one, and out of which about twenty grms. of foul pus is discharged. A large drainage tube is passed in from below through the entire length of the abscess cavity to the upper incision.

Evening : condition of patient good, no pain.

*May 20th.*—Daily change of dressing. The pus has not yet quite lost its foul odor.

*May 25th.*—The drainage tube is cut in two and the two pieces somewhat shortened. General condition good.

*June 8th.*—Patient complains of pain in a circumscribed spot in the middle of the right sterno-cleido-mastoid. Skin on this side somewhat reddened, slightly bulged forward by a hard tumor, the size of a button, situated around and in the muscle.

*June 12th.*—Pain and swelling increased along the inferior half of the sterno-cleido-mastoid.

*June 19th.*—Operation. Skin is cut above the middle of the sterno-cleido-mastoid, and a probe pushed into an abscess cavity lying in the sheath of the muscle. Discharge of about thirty grms. of not quite odorless pus. Counter-opening in the region of the sternal insertion of the muscle. From here a long, large drainage tube is passed upward behind the muscle ; a short one is put in the upper incision. Cleansed with sublimate ; moist dressing.

*June 20th.*—For the first time in eight days again free from pain ; slept through the night.

*June 24th.*—Condition continues favorable.

*June 30th.*—Daily change of dressing. No alteration ; drainage tube gradually shortened ; secretion moderately great ; odorless.

*July 13th.*—General condition every way favorable, no pain, no fever, moderately great odorless discharge. Patient is discharged with four drainage tubes of medium size—one in the inferior

insertion of the sterno-cleido-mastoid, one in the middle, one behind the ear in the region of the mastoid process, one in front of the tragus ; she is dressed daily at her home.

Re-admitted October 30th.

The fistulas in the neck and in the temporal region, one after another, had gradually healed in the course of the last month. The condition of the patient had been good, with the exception of pain felt from time to time in the right linea occipitalis. According to those who had been with her she staggered somewhat in walking. About three weeks ago the pains returned in an aggravated degree, interrupted only by short intervals of relief. At the same time a large swelling appeared in this region ; the patient lost sleep. The appetite remained good and with it also the appearance and strength of the patient. There has been no fever.

*Present condition :* At the right linea occipitalis on the posterior part of the mastoid process and behind it is a diffuse swelling, offering upon superficial pressure jelly-like resistance, on deeper pressure firmer resistance like swollen bone ; it is extremely painful spontaneously, but especially on pressure. The pains radiate towards the right temporal and parietal region, also in a lesser degree towards the neck. No fever ; pulse strong, not especially frequent. Appearance good.

*Therapeutics :* For the present, expectant measures ; ice-bag upon the painful parts with favorable effect, pain somewhat less, but still so severe that sleep is rendered possible only by morphia (0.01). This condition continues two weeks without material change ; constant, usually not very intense pain ; from time to time, particularly at night, more violent exacerbations. Upon consultation with Dr. Burkhardt we decided to make a perforation in the mastoid process. The operation was made by Dr. B. In the first place, on the posterior part of the mastoid process an incision was made about six *cm.* long through the soft parts to the bone. The soft parts were œdematous, macerated, broken down ; in the old scar a small abscess extending to the neighborhood of the periosteum. After forcing back the periosteum the mastoid process was opened with a chisel from behind ; the spongy tissue somewhat softer than normal, very vascular, the marrow much reddened. Nothing unusual about the exposed mastoid cells, particularly nowhere pus. Therefore second incision was made three *cm.* in front of the former one, running downward into it.

The mastoid process opened with the chisel in the usual place. When the opening was about one *cm.* deep the blood showed a purulent admixture; after further enlargement of the opening in the bone about ten grms. of whitish pus escaped from the bone with distinct pulsation. In order to keep the wound in the bone accessible to the eye a part of the flap was cut off. Small quantity of iodoform on the wound; wet compress of borico-salicylic acid.

*November 3d.*—Patient has slept quietly the greater part of the night and apart from slight burning pain in the wound has no more pain; feels as if “new-born.” Change of dressing. The flesh wound and bone cavity cleansed with solution of sublimate. No reaction in the visible part of the wound, the dressing impregnated with blood and pus.

*November 4th.*—The past night was not so good; the old pain returned, but with less intensity; the patient has slept but little (no morphia).

This morning the pain is almost gone again. Daily change of dressing.

*November 5th.*—Not entirely free from pain. Change of dressing. The region of the posterior incision more swollen. On pressure pus was discharged from the interstices between the stitches; the sutures were removed, and a narrow drainage tube introduced. Almost a tablespoonful of pus was removed from this region by syringing. The wound begins to close with unclean granulations.

*November 6th.*—In the dressing a greater quantity of pus, corresponding for the most part to the posterior drainage tube. A larger tube introduced. Change of dressing in the evening.

*November 7th.*—Change of dressing morning and evening. Great discharge from the depth of the wound and from the posterior drainage tube. The granulations begin to cleanse themselves.

*November 8th.*—Very profuse discharge. Condition of patient during the last days variable, never quite free from pain. For two days she has seemed somewhat drowsy, and has been delirious at night. To-day the sopor is also distinctly marked in the daytime; the speech is somewhat inarticulate. Closer examination shows very slight contraction of the right pupil as compared with the left, and less reaction to light. On the right side, in the posterior-inferior region coarse bronchial râles. No recognizable dullness on percussion.

*November 9th.*—Change of dressing morning and evening as during the last days ; discharge still profuse ; sopor increasing ; the voice is hoarse to-day.

*November 10th.*—Discharge less in the evening, but still considerable ; sopor somewhat less ; patient complains of pain in the right half of the frontal bone ; pupils as above ; bronchitis on both sides, especially on the right.

*November 12th.*—Discharge again greater ; patient in heavy stupor ; groans a great deal.

*November 14th.*—Discharge somewhat abated ; consciousness sometimes slightly clearer, never entirely clear ; involuntary evacuation of the bowels.

*November 15th.*—Total loss of consciousness ; several times to-day clonic spasms of the left lower extremity ; in the evening tonic spasms of the left upper and lower extremities.

*November 15th.*—Respiration very frequent ; pulse somewhat intermittent ; well-marked facial paresis of the left side.

*November 17th.*—Death in deeply soporous condition.

*Autopsy.*—The right side of the neck from the mastoid region down to the neighborhood of the sterno-clavicular articulation diffusely swollen. At the upper border of the swelling two vertical incisions, from two to six *cm.* in length, running parallel with each other ; the posterior one corresponding with the posterior margin of the mastoid process, the anterior lying close behind the auricle. Protruding from these are several large drainage tubes, out of which, when the swelling is pressed, dirty yellow pus is emptied. When cut open it is seen that the swelling corresponds to a large abscess, much sinuated, which, beginning above at the side of the skull in the neighborhood of the mastoid process, extends along the course of the great vessels down the neck as far as the sterno-clavicular articulation. From the mastoid process it extends in the form of a sinus about three *cm.* broad, from six to seven *cm.* further backwards in a horizontal direction. This, like the whole abscess, has irregular, thickly infiltrated walls, and the periosteum of the mastoid, of the temporal bone, and of the adjoining part of the occipital bone is also especially involved in this thickening. Along the suture between these two bones, for one and a half *cm.* above and below the foramen emissarium, the bone is exposed and rough. Three *cm.* further backwards is a second rough place on the occipital bone ; also several more such places are seen still further backward. There is nothing abnormal about the roof of the skull or the soft parts covering it.

On opening the cranial cavity the dura mater is seen to be very tense, the superior longitudinal sinus is empty in front, and behind it contains a loose fibrinous coagulum. The pia mater of the convexity is very oedematous and moderately hyperæmic; the pia mater of the base, especially in the neighborhood of the chiasma, is much infiltrated with serum; in the ventricles, which are not enlarged, considerable clear fluid; nothing unusual about the ependyma. Substance of the brain normal, moderately hyperæmic. Over the right tegmen tympani several delicate connective-tissue bands pass from the dura mater over to the pia mater, otherwise the inner surface of the dura mater is at the base as well as everywhere smooth, lustrous, not injected. Sinuses at the base normal, with the exception of the right sigmoid sinus, which, from the point where it turns from the transverse sinus, seems to be entirely obliterated, together with the bulb of the jugular vein and the vein which passes outward through the foramen emissarium mastoideum. Just at this point the dura mater, which elsewhere can be readily peeled off from the base of the skull, is firmly adherent to the bone; after the forcible removal of the dura mater, a hole is disclosed in the temporal bone.

Heart of normal size, in its right half a large fibrinous coagulum. Lungs moderately hyperæmic, oedematous; nothing appears abnormal except an old fibrous cicatrix in the apex of the right lung. Spleen, kidneys, and intestine normal. Gall-bladder doubled in size, contains considerable albumen-like fluid. In Haister's valve is wedged a dark-green cylindrical stone five *cm.* long, one and a half *cm.* in diameter. Capsule of the liver, especially in the neighborhood of the gall-bladder, much thickened. Liver tissue, stomach, and intestinal canal normal.

From the interior wall of the external auditory meatus projects a tumor the size of a bean,<sup>1</sup> closing the entire opening; behind it the meatus is enlarged and filled with pus, and, as the membrana tympani is wanting, its posterior part with the tympanic cavity forms a large cavity filled with pus, in which only the ankylosed plate of the stapes is still visible. The entrance to the mastoid cells leads into the contracted antrum mastoideum, which is filled with pus. The Eustachian tube is much enlarged and filled with pus up to its pharyngeal mouth. A broad canal, the upper wall of which consists of the tense dura mater, leads from the antrum into a cavity the size of a cherry in the fossa sigmoidea (eleven *mm.*

<sup>1</sup> The microscopic examination of the tumor showed the characteristics of a wart (papilloma) with brownish pigment.



long, ten *mm.* broad). The edges of this cavity appear curiously eroded, and are thickly covered with an hypertrophied mucous membrane one *mm.* in breadth, which extends to the upper opening of the cavity. In the lower part of this cavity is another hole five *mm.* in diameter, with which the opening made by the operation, or which perhaps existed beforehand, communicates. From the same cavity a broad canal leads toward the antrum, over which in several spots are defects the size of a pea or less. Another carious passage, following the course of the emissarium Santorini leads into the incisura mastoid. (a frequent point of perforation according to Bezold, with which my own experience fully conforms), which for a distance of about twenty *mm.* presents a carious condition. Around this point, over a space the size of a two-mark piece, the bone is macerated, and at one point there is even a deficiency in the bone the size of a pea, excepting the lamina vitrea, in which the perforation is only the size of an apple-seed. This deficiency is without doubt the effect of a subperiosteal process.

The pus had consequently made for itself the following outlets:

1. Outwardly; the natural way through the meatus was obstructed by the tumor filling it; it flowed off therefore into the wide Eustachian tube, which was filled with pus up to the cartilaginous portion. Part of the pus could, after the vein became thrombosed, pass out of the cavity backward through the incisura Santorini and form the several burrowing abscesses in the neck which were successively opened. Therefore actual eruption of the pus through the dura mater did not anywhere take place.

2. To break through the superior wall of the antrum and the tense dura mater over it was also impossible, therefore it sought to penetrate inward, and in this way caused the excavation under the pyramid, of the size of a cherry, and the destruction of the bony wall of the transverse sinus.

3. Another outlet of the antrum went toward the opposite side, under the dura mater, where the bone is perforated to the size of a small pea on the external side of the petrous bone, at the junction of the posterior and middle thirds of the insertion of the temporal bone in the petrous bone (temporal suture), at the end of the middle cranial fossa.

Here, too, the dura mater was not damaged. The greater part of the pus emptied itself out of the carious cavity into the antrum by means of a wide canal.

4. The most posterior openings which are connected with the abscesses in the soft parts are also upon carious, eroded bone; the soft parts themselves are greatly infiltrated and hypertrophied. The highest opening probably broke at last inward through the tabula vitrea at a small biscuit-shaped place (therefore the very great hyperæmia and infiltration here), but without giving vent to a noteworthy amount of pus, because after the operation this could be discharged outward.

The portion of the jugular vein descending at a right angle above the foramen lacerum (which was covered with hypertrophied soft parts), *i. e.*, the bulbus jugularis, contains a thrombus. (The opening was made from the meatus auditorius internus.) The carotid is intact. The promontory is covered with very hypertrophied mucous membrane. Plate of stapes anchylosed. The utriculus normal. The semicircular canals also apparently normal. Cochlea normal. Dura mater everywhere easily detached, except at the places corresponding to the occiput.

*Remarks.*—If we enquire into the cause of death in this case, which lasted nearly twenty years, and in which the suppuration of the middle ear was accompanied by frequent retention of pus, by polypi, burrowing abscesses, and other grave conditions, we find that it was œdema of the brain and its effects. The œdema is explained by the thrombus in the bulbus jugularis, by the swelling and infiltration of the soft parts lying beneath the dura mater, and also by the intense and extended hyperæmia in the occipital fossa, where a spontaneous perforation of the cranium had occurred only a short time ago. No discharge of pus worth mentioning took place inward, because after the operation it could empty itself outwards. For the same reason the result would not have been changed had a transverse incision been made from the point of operation backwards, in order to give vent directly to the pus here, *i. e.*, to connect the old incision with the new. This is proved by the

decrease in the great infiltration, the swelling and redness of the skin in the region of the occiput a few hours after the operation, which also explains the unusual euphoria and the almost immediate freedom from pain.

The œdema may perhaps be regarded also as an indication of chronic septicæmia, as the symptoms during the last days can be explained also in this way.

In regard to the method of the operation, I beg to remark further: At the operation the cells were first opened without finding pus (the usual incision behind the ear, raspatorium, etc.); the chiselling into the apex of the mastoid process met with as little success; whereupon the operator chiselled upward toward the antrum for a long time without finding pus. It was finally found very deep. It became evident at once that the pus did not come from the antrum, but from a cavity lying posterior to and above it, which from its depth must have been situated in the cranial cavity. Had the transverse sinus not been pushed aside by the capacious pus-cavity (a very exceptional occurrence, and in this case a very fortunate one), it would have been opened, and fatal consequences have been the result.

From this it will be seen how cautious one must be in perforating the mastoid process, and how rigidly the prescribed plan of operation must be adhered to (compare what follows)—*i. e.*, in the right angle, bounded above horizontally by the linea temporalis, which can be felt in almost every one behind the auricle at the apex of the highest convolution of the auricle, and whose other side is a line drawn downward through the spina supra meatum. If the perforation is made here, the antrum will always be found, yet we should never penetrate deeper than 20 *mm.*, if we would avoid entering the semicircular canals. Nor should we go beyond the linea temporalis, if we would avoid injury to the dura mater in the cranial cavity. The opening should not be made further back, as otherwise we shall strike the transverse sinus, which is here only 9 *mm.* distant. The best general rule that can be given is to chisel upward toward the posterior wall of the meatus, and never directly vertically backward, always bearing in mind the

axis of the meatus, which intersects the axis of the operation at an acute angle. We have especially to thank Bezold of Munich for these exact directions, which should be adhered to under all circumstances.

How difficult it often is to make this operation without causing serious injury, and how many variations there are in the course of the transverse sinus, every one knows who has operated on the cadaver, and not without cause have the authors who are most competent to speak on the subject, held that it is justified only by the *indicatio vitalis*.<sup>1</sup> As for myself, having for many years made a distinction between those cases suitable for perforation and those which are unsuitable, and having also had sometimes under treatment for a long time cases that had been discharged by other operators as "cured," I have often enough had opportunity to convince myself on the cadaver of the correctness of the assertion, which I have also expressed in various periodicals, that the only indication can be the *indicatio vitalis*.

And also in such a case I am for an entire separation of the two operations, which have not often enough been kept separate by surgeons, as they should be, because of the surgical anatomy and still more because of the hint which nature gives us in the *fistulæ* of the mastoid process, namely:

1. The opening of the cells of the mastoid process.
2. The opening of the antrum of the mastoid process.

It is well known that most of the fistulas of the bone originate at the above-described point, the spot where the antrum lies nearest to the surface, which is the only one suitable for the operation, *i. e.*, in the right angle formed by the *linea temporalis* and the *spina supra meatum*.

The opening of the cells of the mastoid process has nothing to do with the preceding operation. If one wishes to undertake this, the incision must be carried downward

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<sup>1</sup> Pain alone, though of the most violent kind, furnishes no indication for the operation. This is proved by the cases, and I myself know one such, where a physician insisted upon an operation, and the operator at first declined to operate and desisted from proceeding further when pus could nowhere be found. Later it appeared that the patient was hysterical, and the pain continued after as before.

over the middle of the mastoid process, and then, after forcing aside the periosteum, the bone may be opened directly inward. This operation is indeed very rarely needed, and still more rare is the necessity of chiselling off the apex of mastoid process itself, which, as I have seen in many instances, is absolutely without effect. Bezold has indeed pointed out, and I myself have described a series of such cases (see Reports of Patients, 1880-1882<sup>1</sup>), that a great many abscesses break through behind the mastoid process and in the incisura mastoid., and burrow in the deeper parts. It is then of course of no use to chisel away the apex of the mastoid process. It is self-evident that cases occur where abscesses in the soft parts, as in our case, indicate the point of operation, and then one has no other choice. For the rest, it should be emphasized that it is not always easy to diagnose suppuration in the mastoid process, for I have seen cases where every objective and subjective symptom was wanting and only time brought to light a swelling in the upper part of the neck; which, taken in connection with the previous ear trouble, made the diagnosis of a burrowing abscess tolerably certain. Sometimes these abscesses heal by absorption; at other times by discharging through an opening outwardly, and if they occur in connection with caries or necrosis of the mastoid process, they are attended by the formation of sequestra or the exfoliation of particles of bone.

The oftener and the longer one observes these natural cures the less frequently will one make up his mind to make an operation which in the more severe cases is always accompanied by a certain degree of risk, and which in the lighter is not necessary and unnecessarily creates a large wound. We believe ourselves to be the more justified in this decision as modern surgery, notwithstanding its great and daring performances, is eminently conservative.

II.—*Chronic suppuration of the middle ear of both sides, with extension of the pus into the left cochlea and into the cranial cavity by means of the aquæductus vestibuli; abscess in the cerebellum; death.*

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<sup>1</sup> Report of the Hospital for Diseases of the Ear in Stuttgart, by Dr. Hedinger. E. Koch, 1884.

Mrs. B.,<sup>1</sup> a peasant woman, fifty years old, has had for many years an otorrhœa of both sides, but has never as yet received proper treatment. The hearing power was always very much impaired, especially on the left side. According to her own statement the discharge has been much greater during the last four weeks, so that it appeared necessary to seek medical assistance. During the same time she has been suffering from a kind of whooping-cough, and has been complaining of vertigo and considerable uncertainty in walking. From this time also dates very violent permanent pain in the head, particularly in the occiput, which, especially in the last week, has increased at night so as to become intolerable. She also says that horribly smelling pus and mucus has exuded from the nose into the throat.

*Present condition :* The patient is a cachectic-looking, very emaciated, anæmic woman, who is hardly able to stand.

In the right ear is a firm polypus which reaches to the middle of the meatus and almost fills the canal ; on forcing air through, some pus escapes by the side of it. After removal of two polypi with the snare, only a little pus is seen on the swollen promontory. Membrana tympani entirely gone. Hearing distance and bone-conduction = 0.

Left ear : membrana tympani also wanting ; some coagulated pus lies upon the much swollen promontory ; in the front part of the roof of the tympanum the probe strikes upon carious bone. There is total absence of ærial and bone-conduction. On inflation no pus was evacuated outwardly. Therefore no retention of pus exists.

Now, as the woman wished to be operated on, the question arose : Is there an indication for operative interference ? Will perforation of the mastoid process have to be made eventually ? Can benefit be expected from it, or does not the patient's condition of strength rather forbid for the present any great interference ? As I had to answer the last question affirmatively, I postponed every thing for the present and confined myself to conservative therapeutics, mitigating the intense pain, especially at night, by narcotics and poultices, which gave her some relief. The vertigo as well as the weakness increased, however, and the patient, who took no nourishment, slumbered most of the time until the third day after her admission, when she became comatose. Pulse slow, feeble. Temperature not increased, rather lowered.

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<sup>1</sup> An accurate history of the disease, unfortunately, could not be obtained.

Pupils somewhat contracted ; reaction normal. Patient continued in this condition for two days longer, and died in the night following without again becoming conscious. Marked symptoms of meningitis were absent.

*Autopsy.*—The body is very anæmic and wasted. On opening the cranial cavity attention was at once attracted to the intense hyperæmia of the veins of all the meninges. No thrombus in the transverse sinus of either side. The superior petrosal sinus is also empty. The dura mater is nowhere firmly adherent except in the region of the cerebellum ; at the posterior part of the pyramid of the petrous bone, in the posterior cranial fossa, it is firmly adherent to the bone and thickened, so that it can be removed only with force and in pieces. On the tentorium a very much thickened patch in the dura mater, presenting on its inner side an old cicatrix with irregular edges, which gives evidence of an earlier perforation ; it is covered with a brownish, greasy exudation. In the centre of the superior petrosal sinus is a small hole of the size of the head of a pin, directly over the vestibule, but which contains no pus. On the posterior surface corresponding to the cochlea and vestibule, and beginning at the superior petrosal sinus, the bone is snow-white over a space of the size of a fifty-pfennig piece, and by slightly corroded edges is separated from the remaining, very much reddened petrous bone. (Beginning necrosis.) The line of demarcation had progressed more outwardly than inwardly, and ceased directly beneath the internal auditory meatus. The consistent pus found there came out of the *acquæductus vestibuli*.

On the removal of the dura mater, near the superior petrosal sinus, is seen a thrombosed vessel of the thickness of a silk thread, which can be drawn one *cm.* out of the bone.

On lifting up the hemispheres of the cerebrum, and cutting through the chiasma, on this and to the side of it, floating around free in the middle cranial fossa, appears about a half a coffee-spoonful of discolored flocculent pus, evidently of old origin, which can be traced into the canal of the medulla oblongata. Also in the left posterior cranial

fossa, where the cerebellum rests upon the pyramid of the petrous bone, near the pons Varolii, is found an abscess of the size of a large walnut, containing dreadfully offensive pus. This presents a widely open cavity, with ragged and discolored edges, which is not completely filled, but, as it seems, has previously discharged a large part of its contents—although not long ago. The opening itself is broad, of the size of a small nut. The pia mater over the abscess is destroyed. The dura mater, at the point corresponding to this abscess, is much thickened—as already mentioned,—but nowhere is a perforation to be perceived. The previous existence of one can, however, still be clearly traced in the most thickened patch. In no other part of the dura mater can a perforation be discovered, but it is very decidedly hyperæmic, and, on the base of the cerebellum, very firmly adherent to the cranium.

Tuba entirely pervious, not filled with pus; bulbus jugularis without a thrombus.

After removal of the anterior wall of the external auditory canal, the anterior segment of the membrana tympani is found preserved, callous, and thickened, and adherent to the posterior wall of the tympanic cavity, leaving only a small part of the tube open; the mucous membrane of the remaining tympanic cavity is from two to three *mm.* thick, and covered with small granulations in the antrum. The antrum is very slightly developed, and its lining membrane is covered with cholesteatomatous scales. Had an opening been made, it would probably have struck the sinus. After removal of the mucous membrane of the posterior wall of the antrum, there is found, directly over the Fallopian canal, a triangular opening in the posterior half of the horizontal semicircular canal, of the size of a small lentil, filled with cheesy pus. By this opening a probe can easily pass into the vestibule, and from there on into the cochlea, also into the posterior part of the horizontal semicircular canal, which is laid open by the carious process.

A microscopical examination of the cochlea was unfortunately not possible, on account of the post-mortem changes in the preparation. It also contained pus.



The pus had, therefore, entered the cranial cavity during the purulent inflammation of the cochlea through the acquæductus vestibuli, at the spot corresponding to the beginning necrosis.

*Remarks.*—The following conditions are very remarkable :

1. Very little pus in the petrous bone, while in comparison considerable pus was found free in the cranial cavity, coming without doubt from the not long since ruptured abscess.

2. The absence of an opening in the dura mater can probably only be explained by the supposition that after a perforation and the emptying of pus had taken place in the direction of the cerebellum, the reactive inflammation closed the small opening by means of organized connective tissue. But the pus in the cerebellum caused wider and ever greater destruction, while no new influx came from without. Its discharge took place, on the contrary, through the bursting of the abscess at a later time underneath the dura mater, in the direction of the spinal canal. The coagulated pus, at the point of perforation, was, at any rate, of old date, and formed a sort of plug, a protection from within.

To recapitulate : there was present a purulent inflammation of the middle ear of the left side, involving the antrum, the vestibule, and the cochlea ; and an extension of the morbid process to the cerebellum through the acquæductus vestibuli ; and caries of the petrous bone.

The breaking through took place at a most unusual point,<sup>1</sup> namely, the acquæductus vestibuli.\* Usually it occurs at other points in the petrous bone ; indeed, almost always.

That we could have effected nothing here by an operation, is a matter of course.

The cause of death was probably through long-continued, intense pain, want of sleep, loss of appetite. The pressure of the pus on the medulla oblongata cannot have been of enough significance, as œdema was nowhere present.

<sup>1</sup> According to Bezold's opinion, the tegmen tympani and the sulcus sigmoides are the most frequent points for the transmission of the purulent process ; indeed, very often both serve simultaneously as conducting channels.

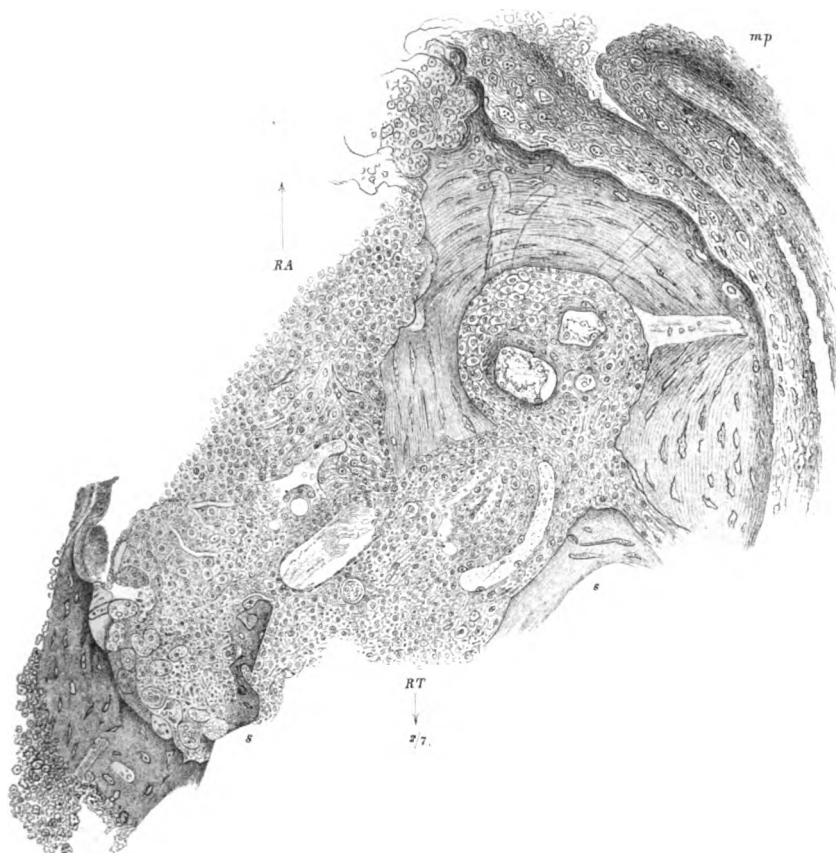
For the sake of comparison, I beg leave to refer very briefly to two counterparts, which I had the opportunity to see lately as specimens in the possession of Bezold in Munich and Rembold here. In the latter there are two carious perforations of the right petrous bone; one in the middle and one in the posterior cranial fossa. The first is on the upper surface, close to the upper edge, in the neighborhood of the tegmen tympani; the second on the posterior surface of the petrous bone, just above the point where the transverse sinus turns into the sigmoid sinus. Corresponding to both points there is at each a chronic abscess of the brain—the one in the temporal lobe, about the size of a hen's egg; the other in the cerebellum, nearly as large as a goose egg, involving nearly the whole hemisphere. The roof of the cavity of the latter is formed only of the thickened tentorium, which is closely adherent to the sides of the abscess, and is broken through at one small point, from which had developed an acute purulent basilar meningitis.

Such a breaking through from two sides, with formation of an abscess in the cerebellum, as well as in the cerebrum, is indeed a great rarity.

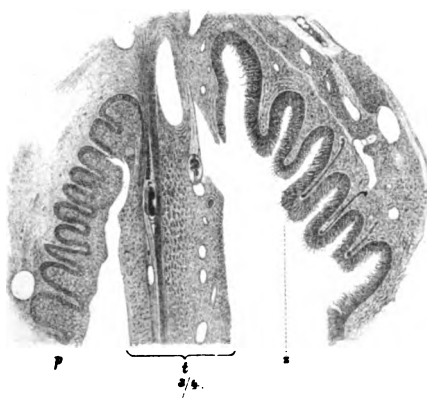
In Bezold's preparation a great part of the membrana tympani was intact (only its posterior upper part was adherent to the wall of the tympanic cavity, and here a polypoid granulation covered it), a perforation was visible in the region of Shrapnell's membrane, which led directly into a cheesy and cholesteatomatous mass in the entrance to the autrum and in the antrum itself. Discolored spots were found as well in the tegmen tympani as in the sulcus sigmoideus; the transverse sinus, the bulb of the jugular vein, and the internal jugular vein were filled with discolored thrombi. In this case death resulted from pyopneumothorax, as a sequence of pyæmic infarction of the lung.



I.



II.





# ARCHIVES OF OTOLOGY.

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## OTITIS HÆMORRHAGICA.

By P. McBRIDE, M.D., F.R.C.P.E., F.R.S.E.,

SURGEON TO THE EAR AND THROAT DEPARTMENT, ROYAL INFIRMARY; LECTURER ON DISEASES OF THE EAR AND THROAT, SURGEON'S HALL, EDINB.; AND SURGEON TO THE EDINBURGH EAR AND THROAT DISPENSARY.

IT is now some years since Roosa first called attention to a peculiar form of acute inflammation of the middle ear, which he designated otitis media hæmorrhagica. Since then the affection has been more or less generally recognized, and a considerable number of instances have been recorded (compare "Diseases of the Ear," by St. John Roosa, 6th edition). Such being the case, I had no intention of adding to the literature of the subject, although three very distinct examples have come under my notice, and this must be my excuse for the very imperfect records of my own cases—which are, indeed, principally from memory. My reason for now putting pen to paper is that I believe myself to be, through accident, enabled to explain what, to my mind, at all events, seemed to be a pathological anomaly. Hemorrhagic otitis media, as described by Roosa and observed by myself, usually runs a very acute course. Thus my first case was somewhat as follows:

A young married gentleman was travelling by train and suddenly felt most excruciating pain in his ear. In a very short time he felt something give way, and quite a free hemorrhage occurred. On getting home he sent for me, because he was alarmed by the bleeding. In this case, inflammation of the meatus and suppuration of the middle ear afterwards set in.

My second case (of which I retained short notes) curiously enough also affected a gentleman after travelling

by railway. Mr. P. had severe pain in the right ear on Friday evening. During the night it bled, and the pain was relieved. The condition on Monday afterwards was as follows: H. D.: watch normally heard at thirty inches, only perceived on contact; tuning-fork best heard in bad ear; right membrane shows signs of past inflammation and covered in part with clotted blood; pharynx congested. In this instance the hearing was much improved by treatment directed to the pharynx, together with the use of Politzer's bag.

My third case was hardly so typical as the others, for in it blood only escaped after incision of the membrane, a proceeding which was rendered necessary by great pain and evident bulging. The color of the drum-head in this instance was bright-red, as is usual in acute otitis media; but after paracentesis and the evacuation of the tympanic cavity the color was more bluish-gray.

The leading characteristics, then, of otitis media hæmorrhagica seem to be (1) great violence of its symptoms; (2) rapid course; (3) the escape of blood instead of pus.

One is naturally inclined to ask, whether we have any analogous form of inflammation in other organs, and, so far as I know, the answer must be in the negative. It is true that hæmorrhagic retinitis presents some resemblance, and, indeed, Roosa has found the two conditions associated; but it is well to remember that retinitis hæmorrhagica is commonly met with in gouty persons, whose vessels are presumably diseased, while otitis hæmorrhagica, although its occurrence, as we shall see, is favored by weakness of the arterial coats, is quite frequently found in persons in the prime of life and strength. There has of late been described a hæmorrhagic form of laryngitis, but it is not analogous to the condition in question, because, in the first place, the signs and symptoms of acute inflammation are but slight; and, in the second place, it is quite likely that the hæmorrhage may be due to the associated cough. (Compare "*Krankheiten des Kehlkopfes*," by Gottstein, p. 64.)

Having then pointed out that there is met with in the tympanum a form of inflammation which in its combined

clinical and pathological characters differs from the various recognized types, we must next consider its etiology or, better, pathogenesis. Roosa explains its occurrence in the following sentence: "They are, I think, to be considered as cases of acute inflammation of the lining membrane of the middle ear, in which the morbid process has an unusually rapid and violent course, so that not merely an exudation through the walls of the vessels, but an actual breaking down of the walls themselves occurs." So far as this explanation goes it is probably correct, but it leaves unexplained why such a form of inflammation should occur in the ear, and there alone, for otitis hæmorrhagica cannot be compared with the hemorrhagic inflammations and exudations which occur in morbid conditions of the blood. We must, I believe, look for further elucidation to the physical conditions of the tympanic cavity. It will be remembered that the early changes of inflammation are characterized by dilatation of the arteries, which goes "on increasing for ten or twelve hours [Payne: "Quain's Dictionary of Medicine"] till these have double their original diameter and pulsation becomes very prominent in them." If we take this into account, and if we further assume that the inflammation occurs on a surface which is under less pressure than any other part of the body, it requires no great stretch of imagination to suppose that, instead of running its usual course, it should be suddenly aborted by the rupture of the distended arterioles. Now this combination of physical conditions is quite likely to happen in the tympanum, but is not easily imaginable in any other part. Every aurist is familiar with cases of advanced middle-ear catarrh in which there is marked obstruction of the Eustachian tube, but in which the drum-head, owing to thickening and want of elasticity, is by no means drawn inwards to a corresponding extent. When such a state of matters is present, the intra-tympanic structures are always under less pressure than other parts, and so in a condition favorable to the development of inflammatory hemorrhage. Again, acute inflammation may manifest itself in the Eustachian tube some time before the tympanum is affected; if then the former



be quite closed, a condition of the latter similar to that described in the preceding sentence occurs.

So far I have stated my belief that the inflammatory form of otitis media is usually due to preceding acute or chronic obstruction of the Eustachian tube, especially if associated with a thickened drum-membrane; it may of course also occur as a result of diseased vessels. That diminished pressure increases the tendency to hemorrhage must be self-evident to all, and as an example I need only mention the frequent occurrence of retinal hemorrhage after the operative relief of tension. The following are brief notes of a case which recently came under my care, and which seems to me to explain and illustrate the pathogenesis of hemorrhagic otitis media.

Mr. — consulted me on the 16th of February. Three weeks ago he went into a caisson; he has had an excessive discharge from the nose for six months since his return from America. In the caisson he felt his ear very painful, and having misunderstood the directions given him he swallowed, instead of performing Valsalva's experiment. During that night, and since, he has had a feeling of distention in the head, which disappears when pressure is made on the parietal or auriculo-temporal region. No giddiness or tinnitus. Tuning-fork is heard louder in the right (affected) ear. Had the ear syringed by a doctor, but it did no good.

H D : watch, L,  $\frac{7}{30}$ ; R,  $\frac{1}{30}$ .

Left membrane slightly indrawn, but otherwise normal.

Right membrane is much indrawn above, and its lower part is of a dark purplish-blue color, while above and in front there are pale brown patches (serous exudation). Inflation by Politzer's method causes the membrane to move outwards, and leaves only a bluish patch in the centre; H D is also increased to  $\frac{3}{30}$ .

The throat is catarrhal, but unfortunately posterior rhinoscopy was not practicable.

*Treatment.*—Syringing the nostrils gently with a solution of borax and soda and the air-bag.

*Feb. 16th.*—H D :  $\frac{\text{gentle contact}}{30}$ , membrane much depressed, incus prominent, color still purple; after inflation, H D :  $\frac{3}{30}$ , membrane well forced out, *lower part* shows dark color, probably due to free clot.

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17th.—Membrane again indrawn, and showing dark coloration in lower part, surrounded by a rim of gray color. H D :  $\frac{1}{30}$ ; after Politzerizing,  $\frac{3}{30}$ .

18th.—Dark color less, and disappears on inflation, but there then appear (1) bladder-like bulging behind, (2) large bubbles dividing the membrane into segments.

H D :  $1\frac{1}{4}$ . Not changed by inflation, or, I should rather say, showing improvement for a second or two and then falling back again.

19th.—H D :  $\frac{3}{30}$ . Membrane shows less dark coloring, and is not so indrawn. Posterior inferior segment markedly bulged. Color of lower part as in serous exudation. H D, after Politzerization, with head forward and to opposite side :  $\frac{4}{30}$ . No signs of fluid after inflation. Patient to use air-bag at home, with head forward and to opposite side.

26th.—Has not been so well. H D :  $\frac{1}{30}$ . Has been giddy. Air has evidently not entered at home. Membrane indrawn, no purple color, yellow tinge still present. Moist râles on inflation, and H D raised to  $\frac{3}{30}$ . Paracentesis, with egress of much straw-colored serum. H D :  $\frac{6}{30}$ . Great relief of "stiffness about the head."

27th.—H D : R,  $\frac{6}{30}$ .

Blood at seat of incision, and membrane very slightly indrawn.

March 3d.—H D :  $\frac{2}{30}$ . Return of discomfort, giddiness, etc. Reaccumulation of fluid, paracentesis, and immediate relief, which I presume has continued, otherwise the patient was to return.

This case was obviously, in the first place, one of sudden hemorrhage into the tympanic cavity, and when first under observation the latter contained blood-clot and serum. The presence of the blood-clot was shown by the dark purple color of the membrane, which changed its character after inflation, thus proving its appearance to be due to hemorrhage behind the drum-head. The bleeding was easily enough accounted for by the increased pressure of the compressed air, the neglect to perform Valsalva's experiment before entering the chamber, and the presence of chronic naso-pharyngeal and middle-ear catarrh, all of which circumstances combined to place the intra-tympanic structures under a condition similar to that of the parts under an exhausted cupping-glass. The hemorrhage then, in this

case, goes far to prove the correctness of the view we have taken of the pathogenesis of otitis media hæmorrhagica ; there are, however, some other points of interest in connection with the case, to which it may be well to refer shortly.

The fact that the patient could, by pressing upon the temple and parietal region, temporarily free himself from the uncomfortable feeling of intra-cranial tension, calls for remark, but is difficult of explanation. We must probably look upon this phenomenon as analogous to the cessation of tinnitus, which can sometimes be effected by pressure over the mastoid and seventh cervical vertebra, and also at times by blowing upon the cells of the external meatus ; the explanation is probably to be sought in a vaso-motor connection.

Another point of interest was the presence of serous exudation before and after the absorption of the blood-clot, for I have no doubt that the yellow color observed above the upper margin of the purple discoloration (when the case was first seen) was due to the presence of serum. It must, I think, remain doubtful to which of the following causes the watery exudation was due, viz. : (1) hydrops ex vacuo ; (2) irritant action of the clot ; (3) absorption of the clot before the serum.

It is possible that the blood-clot may have been so placed as to prevent the passage of air into the tympanum, and thus have produced diminished pressure in the free part of the cavity with secondary serous exudation. This view was favored by the very marked and obstinate indrawing of the upper part of the membrane. The second hypothesis—that the serous exudation was due to the irritant action of the clot—does not seem probable, because there was no pain or other symptom pointing to inflammatory action. Absorption<sup>1</sup> of the clot before the serum is sometimes met with in apoplexy but not often ; that it occurred in this case seems at first sight certain. It must, however, be remembered that inflation may have been each time followed by the absorption of a part of the clot and serum, while, whenever the supply of air so gained was absorbed, a fresh hydrops ex vacuo may have occurred.

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<sup>1</sup> "A Manual of Pathology," by Ernst Wagner, p. 507.

## THE USE OF BICHLORIDE OF MERCURY IN OTORRHŒA.

BY H. L. FERGUSON, DUNEDIN, N. Z.

I HAVE for the past five years used the dry treatment almost exclusively for otorrhœa, and at home—that is, when I was in Dublin,—I was in the habit, when the powder used, whether boracic acid or iodoform, was caked or moistened with discharge, of syringing it out with warm water. Since I have been out here I have used a warm one-per-cent. solution of carbolic to syringe all ears in which the drum is not perfect, and am under the impression that my results are better.

Last October I was induced, by the glowing accounts in the British and American journals of bichloride of mercury as an antiseptic, to substitute a one-in-two-thousand solution of the bichloride for the carbolic.

I used it in about a dozen cases of chronic otorrhœa, and in several noticed considerable hyperæmia of the membrane subsequently, which in two cases went on to severe myringitis. In one case, a man of about forty, with a large perforation in front of the handle of the malleus and old-standing discharge, a slough formed behind the malleus, which separated, leaving a second perforation, which has proved permanent. In the other, a boy of eighteen had a small central perforation and discharge from childhood. The caked boracic acid was syringed out with the bichloride solution on the 3d and again on the 4th of November. Subsequently he had severe pain, and on the 5th had enormous swelling of the membrane, for which I had to incise it freely,

enlarging the perforation to the floor of the drum. Pus followed the knife from the membrane, and in his case the inflammation led to the formation of a false membrane, which united the edges of the perforation to the promontory and closed the old perforation. Both have been under observation before and since and suffered no irritation or inconvenience from the carbolic solution. In neither case was the hearing subsequently impaired, but they have to thank Sir Joseph Lister's optimistic praise of the new antiseptic for their attacks.

I am now using the carbolic, in which I always put some bicarbonate of soda, to raise the specific gravity of the fluid. I find that in ears with perforation of the *Mt*, where the Eustachian tube is free before syringing, if water or plain carbolic solution is used and passes down the tube, the tube is not, as a rule, free to Valsalva afterwards, owing to the swelling of the mucous membrane from absorption of the water. If, however, I raise the specific gravity of the solution with salt or sod. bicarb., the absorption does not take place and the tube remains free. Of course the same action takes place in the cavity of the drum as in the tube, but I am not aware of any one having suggested this simple precaution.

If I am writing rubbish, Mr. Editor, please put it behind the fire. I am so out of the world here that I feel as if I must be quite unable to estimate the value of a case or observation. I have frequently cases I should like to send you for publication, but always have a feeling that something may be going on I do not know of here, and that I am behind the age, though of course I am only six weeks away. I miss the reference libraries of the old country very much, and all the new books I get are, alas, in most cases, of little use except to make me feel that there is not so much being done after all.

## WHOOPING-COUGH AS A CAUSE OF DEAFNESS.

By M. S. FALLS, M.D.,

ASSISTANT TO DR. BURNETT'S EYE AND EAR CLINIC, CENTRAL DISPENSARY, WASHINGTON,  
D. C.

FROM a careful examination into the predisposing and exciting causes of deafness, I was much impressed with the scant mention made of whooping-cough as an etiological factor. While our text-books and journals are very prolific in assigning the exanthemata, diseases of the larynx, and even gastritis as agents of causation, whooping-cough, beyond the few authorities given below, is entirely ignored.

I consider pertussis as probably not a rare cause, but in dispensary practice, from which most of the cases have been taken, the time given to each case for examination is so extremely limited, that the history elicited is, as a rule, imperfect, and inadequate to our wants.

Wilde, on "Diseases of the Ear," Phil., 1853, p. 495, cites five cases in which the deaf-mutism was considered the result of whooping-cough. He further says in this connection: "In what way whooping-cough produces deafness, whether by local injury to the ear, such as occurs during a violent paroxysm rupturing the membrana, or from its effects on the nervous system, I am unable to say. Every one is aware of the many anomalous consequences which follow pertussis and popularly denominated 'the dregs of whooping-cough.'" Roosa, 6th ed., p. 685, reports in his statistics two cases in which deaf-mutism was assigned to pertussis. Peet, J. M., New York, 1856, pp. 53-56, tabulates twelve cases of deaf-mutism due to whooping-cough.

That rupture of the membrane can occur from violent paroxysms of coughing I do not doubt, for several cases are recorded in which the violent strain from the cough has been followed by cerebral effusion, with paralysis as a result. But in the cases coming under my observation, and that of Dr. Burnett, Director of the Ophthalmological and Otological Clinic of the Central Dispensary, the membrane was intact in all. That the deafness may be due to extension of inflammatory action from the throat I also admit; for when we consider the relative vascularity of the membrane in children and adults, we will find that the blood supply to the former is much greater, and that whooping-cough, although considered by some writers with diseases of the larynx and trachea, is not infrequently attended with hyperæmia of the Eustachian tube and tympanum.

But in the cases which I present for consideration, we would not be warranted in ascribing all of them to an inflammatory extension from the pharynx; rather let us look for some nervous implication, as the deafness was in the majority of cases absolute, since neither the vibrations of the fork nor the ticking of the watch could be heard when applied to the teeth or cranium, or when held close to the ear. In view of the above we think that the following cases taken from Dr. Burnett's clinic will not be without interest:

CASE I.—A. E., æt. eleven years. Admitted to the clinic at the Central Dispensary May 22, '85. The boy presented every evidence of scrofula, and had been treated for Pott's disease by Dr. S. W. Gross.

Twelve weeks ago, had pertussis attended with great straining. Two weeks ago hearing was suddenly lost, the deafness being absolute, commencing late in the evening, and, on the following morning, hearing in the left ear was lost. This was attended with some pain, but no discharge, vertigo, or vomiting. This pain persisted for two days, and then left the patient as suddenly as it began. *Mt* intact, but slightly more concave than normal. Pyramid of light not visible to the periphery of the membrane in either ear. Put upon specific treatment. June 8th: Gives manifestations of tinnitus aurium. Complaining to his sister of "a

roaring" in his head. Since put upon specific treatment, some vomiting and nausea immediately after taking the medicine. Dose reduced one half. No improvement in hearing. Have seen the boy several times since, but so far no amelioration.

CASE 2.—S. B., æt four years. A mulatto boy, presenting every evidence of the scrofulous cachexia. On June 2, '85, when he was first admitted, his mother gave a history to the effect that, since March, he has had an attack of whooping-cough. Two or three weeks after the onset of the disease he suddenly became deaf (not absolute). Three weeks ago, discharge began in the right ear, none from the left. Complains of no pain. Loud voice at one foot, with either ear. Noticed unsteadiness of gait. *Mtt* slightly thickened and red. June 9th, less injection of membrana. Voice in either ear, one foot; probable increase of hearing after Politzer. June 9th, for two days pain in right ear. June 16th, gait normal; no pain; deafness persistent.

The following cases, of a similar character to the above, I report by the kindness of Dr. Burnett, from whose private case-book I copy the notes.

CASE 3.—M. J., white, æt thirteen years, had whooping-cough when about five years old. During convalescence, his parents noticed that his hearing power was defective. He became totally deaf within a year. No pain or discharge. *Mtt* normal.

It is of interest to note in connection with this case, and as bearing on the possible inherited tendency to deafness at a certain age, that a brother of the above had scarlet-fever at five years of age. No inflammatory affection of his ears, but his hearing gradually left him, and in twelve months he was completely deaf.

CASE 4.—H. S., white, æt. twelve, had suffered from impaired hearing, in right ear, as noticed by his parents since an attack of whooping-cough. Never any pain or discharge. L, W., fourteen feet; R, W., faintly on contact. *Mtt* normal; tubes pervious; no improvement after inflation.

The above cases occurred in Dr. Burnett's practice, in 1876.

The data furnished by these cases are not sufficient to



warrant any positive conclusion as to the causative relation between pertussis and deafness, or as to the manner in which the ear affection is brought about, but the existence of a connection between the two seems highly probable.

Cases 1, 3, and 4 would appear to be purely nervous in their character, while in case 2 there was a middle-ear complication, which, however, probably only served as a complication.

## COCAINE IN "EARACHE."<sup>1</sup>

By A. G. HOBBS, M.D.,

PROFESSOR OF EYE, EAR, AND THROAT DISEASES IN THE SOUTHERN MEDICAL COLLEGE,  
ATLANTA, GA.

**I**T is the style now to use hydrochlorate of cocaine in all imaginable aches and pains, and were it not for the high price of the salt I have no doubt it would be used still more indiscriminately.

It is almost established now that its use should be confined to mucous membranes; at least, so far as my experience goes, it is useless to apply it to the skin, or even to depend upon its physiological effects when applied hypodermically.

The literature upon the subject is already profuse, notwithstanding the salt has only been in use about six months. In the last number of the *ARCHIVES OF OPHTHALMOLOGY* Dr. Knapp has given a summary of all that has been written about cocaine, showing the great variety of cases in which it has been tried. A physician lately said to me that he was greatly disappointed with cocaine, because he had used a strong solution in a case of "earache" without any effect. As well might he have rubbed the same solution upon the skin of the finger to ease the pain of a bone-felon. He had proceeded upon the principle that the external layer of the drum-head was mucous membrane, and not skin, and that the cocaine would penetrate the membrane and gain access to the lining mucous membrane of the middle ear—the seat of the pain in so-called earache.

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<sup>1</sup> Since writing the above, some weeks ago, I have treated five more cases in the same manner, with good results in four.—H.

The case alluded to above was sent to me while the pain from an acute inflammation of the middle ear was still in its acute stage; the pain was almost immediately relieved by the application of cocaine—not through the external auditory canal, but through the Eustachian tube. Two drops of a two-per-cent. solution were blown through a warmed silver catheter into the tympanum; the pain returned, but in a less degree, in about two hours, when I inserted two drops of a four-per-cent. solution, which gave ease for eight hours; after this the pain was controlled by spraying a solution of cocaine and glycerine into the corresponding nostril, and immediately resorting to Valsalva's method of inflation. I have treated six other cases in almost exactly the same manner as the above case, and the desired result was gained in a greater or less degree in all. In one of these cases a tinnitus, that had existed about six months, from a previous inflammation, was entirely relieved. I do not say that the cocaine stilled the roaring in this case, but every aurist knows that in most cases a tinnitus is increased instead of diminished by a recurrent attack of middle-ear inflammation.

## A CASE OF HYSTERICAL DEAFNESS, WITH REMARKS.

By JOHN F. FULTON, M.D.

PROFESSOR OF OPHTHALMOLOGY AND OTOTOLOGY AT THE MINNEAPOLIS COLLEGE HOSPITAL.

**A**LTHOUGH cases of hysterical amblyopia in which there is a diminished sensibility of the retina and optic nerves are occasionally met with, cases of hysterical diminution of the functional activity of the auditory nerves seem to be extremely rare. In fact, many of the best text-books fail to mention the subject, and others hint at it in vague terms. My attention has been called to the subject by a case which came under my care in private practice some months ago, which I think of sufficient interest to be reported in detail, as it opens up comparatively a new field for investigation, and calls to our mind another factor in the consideration of the treatment of maladies of the ears and their appendages.

On the 20th of May, 1884, Mrs. H., aged thirty-six, called at my office complaining of being quite deaf, and that it had come on quite suddenly. She was referred to me by her sister, who I had treated successfully for chronic suppuration of the middle ear. Seeing at a glance that my patient was of a highly nervous temperament, pale, and quite anæmic, I began by making inquiries as to her constitutional trouble, which brought out the following history :

The patient has always been subject to violent mental emotions—fits, laughing, crying, sobbing, with elevation and depression of spirits. There are frequent contractions of the various groups of muscles and sense of constriction at the pit of the stomach—well marked. She complains that she has been very much annoyed

with palpitation of the heart, and speaks of a long train of nervous symptoms—all hysterical in their nature and all exaggerated by the patient. One day the patient comes to the office complaining of one set of symptoms, the next of another.

The history of the case showed, however, that the paroxysms of hysteria were not so prominent as the extreme susceptibility of the nervous system. While under treatment this showed itself constantly from day to day. There was no suspicion of this lady's trouble being feigned. She was most anxious to be relieved. A careful examination failed to reveal organic disease of any organ.

Two years previous to the date of the patient's first visit to my office she had an attack of ear trouble similar to the one that now annoys her. The deafness came on suddenly, associated with slight dizziness, but could hear some days much better than others. Some days it would require loud shouts of the voice to be heard, other days she could hear the tick of a watch. Her general health was very poor at the time. She applied to the late Dr. Atwood for treatment. He evidently had treated her for chronic catarrh of the middle ear. She derived no benefit from the treatment. Went to the country for a few weeks, and returned with her acuteness of hearing normal and general health much improved. She came to my office, as above stated, complaining of her second attack of aural trouble. It came on as in the former case, with all the symptoms worse. The dizziness and tinnitus very distressing. There is no pain. It cannot be noticed that there is any difference in the ears. Their acuteness of hearing is the same. The watch cannot be heard on contact with either ear. For the voice the acuteness of hearing is about one half that of normal. Politzerization improved the hearing very little, if any. The examination of the external canal and ear drum and adjacent parts gave negative results. There was a slight catarrhal condition of Eustachian tubes and middle ear, but not sufficient to account for the trouble. There was no amblyopia; no motor or sensory paralysis. The "come and go" hearing being like the "come and go" vision of hysteric amblyopia, was a marked feature of the case, and could only be accounted for on the basis of hysteria.

After the patient had been under my observation for some days, and seemed to be much improved, she came into the office one morning more deaf than ever. The day before some domestic difficulty had arisen which gave rise to excitement on the part of

our patient, and thus produced the dulness of hearing. A few days later she was feeling much better, the spirits were hilarious, and the acuteness of hearing became almost normal. During the attacks of dulness of hearing the bone-conduction was very much diminished, and at one time seemed almost absent. It ceased considerable sooner than the aërial conduction. The application of the galvanic current always improved the hearing, but this was the only therapeutic agent that seemed to have any appreciable effect. Nutritious food, cheerful company, and plenty of open-air exercise gave valuable assistance in bringing about a favorable result. This was indicated by the complete removal of the subjective noises, the improvement in the acuteness of hearing, and the very great change of the general health for the better.

It should have been stated earlier in the history of this case that there were times when sounds seemed abnormally loud to the patient, and the ordinary tones of conversation would annoy her. These would come on first, and would be followed by depression and the lower condition of sensibility of the auditory nerve. She had some trouble with the uterus, and commenced to have it treated while under my care, and claimed to improve much more rapidly after this.

Cases of true hysterical deafness must be extremely rare. Dr. Burnett, in his work ("A Treatise on the Ear"), in speaking on this subject says: "Dr. S. Weir Mitchell has called my attention to what he terms hysterical deafness. In the case of a young woman he observed a deafness which would apparently come and go during conversation. At other times the patient would fail to hear under circumstances in which she had but a short time before appeared to hear well. I have never observed such a case, but I doubt not that such should be classed under hysterical phenomena." Dr. A. Magnus, in *Arch. f. Ohrenheilk.*, has a paper on "A Case of Complete Transient Deafness," in which, after referring to the different possible diagnoses, he pronounces it a case of hysteric deafness. But the literature on the subject is quite scarce. Politzer says: "Peculiar sensations in the organ of hearing are not uncommon in hysterical subjects. Patients complain frequently of a constriction and pressure in the ears, of

purling, gushing, and crawling in the interior of the meatus, and of increased sensibility to noises without any perceptible disturbance of hearing. On the other hand, deafness of undoubtedly hysteric character is very seldom met with, according to the observation hitherto made, perhaps even more seldom than hysterical amblyopia."

Walton has made some interesting observations on this subject. In a paper of his published in *Brain*, on "Deafness in Hysterical Hemi-Anæsthesia," he points out that in total hemi-anæsthesia the *Mt* can be touched without pain, and the sound-perception is reduced on the affected side; neither could the entrance of air into the middle ear be felt on this side. In the partial hemi-anæsthesiac all these symptoms were noticed, but in a less marked degree. In the bilateral cases of anæsthesia which Walton examined, there was bilateral deafness corresponding to the degree of the loss of sensation. In all of the cases the ærial vibrations of the tuning-fork were better perceived than bone-conduction.

The relationship of hysteria with all the organs of special sense is a very interesting study, but it is extremely difficult in ophthalmic and aural practice to separate the true hysterical symptoms from those having a distinct pathological basis. Hence the great care with which these cases should be studied and the importance of a detailed report of all such.

Interesting, too, in this connection is the influence of diseases of the uterus on diseases of the ear. It will be remembered that as soon as the patient's uterine trouble was treated her ears improved more rapidly. Weber-Liel has written a paper on this subject in the *Monatsschrift für Ohrenheilkunde*, in which he says the affections of the sexual organs of the female, and even the physiological accomplishment of their principal functions, produce a marked effect on diseases of the ear. When pregnancy, flexions of the uterus, etc., occur in the course of ear disease, the progress and character of the latter are markedly modified. A simple catarrhal otitis, which is often insignificant, may become complicated with considerable disturbance of the

nervous and circulatory systems, and the treatment of the ear disease becomes useless as long as the abnormal condition of the reproductive organs is maintained. When that is relieved, the affection of the ear is healed in turn. In the case which I have here reported the trouble with the uterus was a complication, and not the cause, of the deafness. But the influence of the other organs on diseases of the ear is one that is too little thought of, the importance of which is amply shown by the careful study of cases such as this one and those pointed out by Weber-Liel.



## RESTORATION OF THE CLOSED FAUCIAL APERTURE BY REPEATED OPERATIONS UPON THE SOFT PALATE.

BY WILLIAM B. WOOD, M.D., OF NEW YORK.

*(With three wood-cuts.)*

William McD., age eighteen, was brought to me in April, 1884, on account of his inability to articulate and breathe through his nose. On examination the condition shown in fig. 1 presented itself. Upon elevating the uvula, a small aperture, one line in diameter, appeared, as in fig. 2, and was the only communication between the naso-pharynx and the throat. When four years old he was very ill with what was said to be scarlet-fever, and a very bad throat. The well-defined lines of cicatricial tissue established the fact that the soft palate grew to the posterior wall of the pharynx during this illness. The hearing was normal, and the appearance of the drum membranes fairly good.

The difficulties in operating in these cases have been found to be from hemorrhage; from the remarkable persistency and rapidity with which the cut surfaces grow together; from the fact that in articulation the soft palate must have a certain definite relative position to the surrounding parts, must support the uvula, and possess a definite power of motion with a good degree of flexibility. It would be comparatively easy to give a good breathing aperture, but to secure a soft palate and posterior pillars, that make articulation possible and speech intelligible, requires the utmost caution, a maximum of patience, and constant practice of vocal calisthenics.

It was decided to attempt to attain a successful result in this case by a series of small operations, combined with constant training in the hands of a specialist in articulation.

After two hundred and fifty sittings during fourteen months,

the result seen in fig. 3 was obtained, giving the patient the ability to breathe and articulate with entire success.

The vocal training was actively pursued during the entire fourteen months, and reports of the patient's progress in articulation made after every operation, thus enabling me to determine how far and in what direction to operate. The greatest difficulty experienced was in keeping the cut surfaces apart so as to prevent reunion.

Another difficulty encountered in this case was the mental deficiency of the patient—his father being a victim of alcoholism,—and the fact that he could not be relied upon to use his newly acquired power except when compelled to. It is probable that a good deal of contraction will occur again, due to this failure on his part, and this may necessitate a further series of operations later on.

Miss WARREN undertook the vocal training of the patient, and has kindly written the following account of the methods pursued :—

Various experiments have proved conclusively that pure vowel sounds can be made only when the soft palate is raised, its edge being in contact with the posterior wall of the pharynx, or very nearly so. A wire of the size of a strong thread has been carefully introduced through the nose until one end could be seen below the soft palate ; when the outer end was moved, the part hanging down the pharynx could be seen to sway from side to side. When pure vowel sounds were given (*ee*, as in see ; *a*, as in pay ; *o*, as in no ; *oo*, as in poor ; *a*, as in father), no motion could be produced, the contact between the soft palate and the posterior wall of the pharynx being so perfect that the wire was held fast. A thread, with the help of a small tube, was inserted in the same manner as the wire ; both ends were pulled, the effect being to slightly remove the soft palate from the wall of the pharynx, the vowels being again uttered ; at first no change was observed, but at a certain point, (roughly speaking at an aperture of .045 sq., in.) the nasal intonation became suddenly perceptible.

If the opening be made larger by swollen tonsils interfering with the elevation of the soft palate, by the bad habit of an individual of not raising the latter sufficiently, or on ac-

count of a "cleft palate," the nasal peculiarity of the voice may increase from a "twang" to a complete change of sounds, rendering speech unintelligible. This has all been proved in my experience in overcoming defects of speech, and in teaching correct articulation to persons having artificial palates. Three consonants only—*m*, *n*, *ng*—are formed by allowing the voice to pass through the nasal passages, the soft palate falling upon the tongue; these are capable of

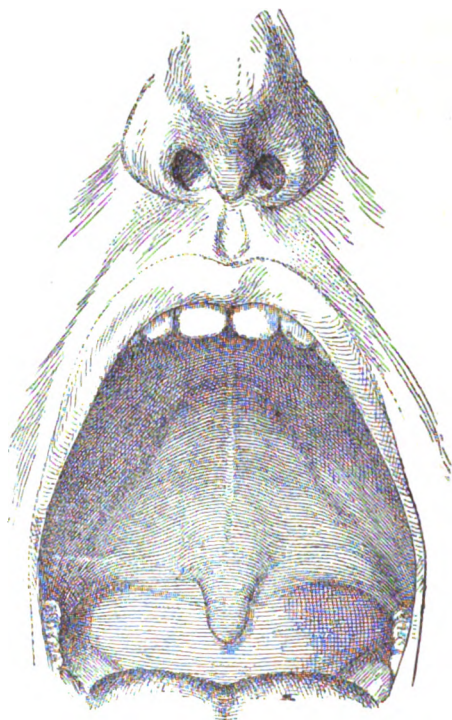


Fig. 1.

being prolonged during an entire expiration. The slightest tinge of nasality in a vowel or in any other consonants than those mentioned above is objectionable in our language; thus the action of the soft palate must be constant and prompt.

In the case under consideration, the soft palate being fastened back (see figs. 1 and 2), could not act properly during articu-

lation, and the breath found no outlet through the nose ; in consequence, the three nasals—*m*, *n*, *ng*—were muffled and scarcely noticeable ; the mouth was used for both currents of breath, the inspired and the expired, causing frequent breaks in a sentence of a few words ; the boy was unable to blow his nose ; and all the vowels that require an expansion of the soft palate accompanying the action of the tongue, were necessarily lacking in purity. The movements of the tongue itself were sluggish ; this was not wholly due to the condition of the palate, however, but to lack of effort on the part of the boy. *S* and *th* were the only elements of the language that he could not give when not combined with other sounds ; but when he attempted to speak a syllable or a sentence his speech was unintelligible.

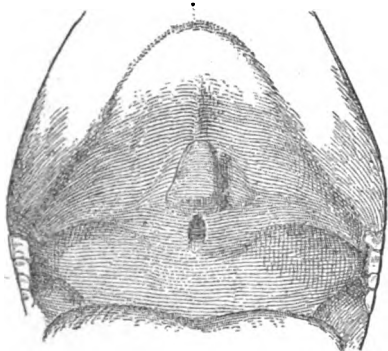


Fig. 2.

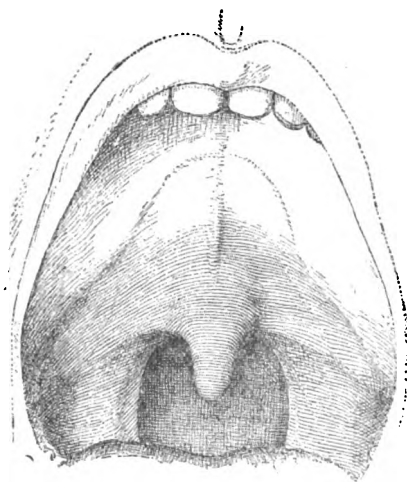


Fig. 3.

Fig. 3 shows the present appearance of the palate. The breath has a proper outlet through the nose ; the nasals are given clearly and can be prolonged ; the mouth need no longer be used for the inspired current of breath ; the boy can blow his nose properly ; and he can read and speak distinctly. On Feb. 7, '84, I first gave him a drill on the elementary sounds and other exercises for the purpose of training his tongue to prompt and correct action. By May 9th he spoke clearly, but with an effort. His lips were without strength ; he could not hold them together unless he supported his chin. After Nov. 3, '84, lessons were given daily.

Breathing exercises were begun, and the drill on elementary sounds continued. The first indication of the working of the soft palate was noticeable on Nov. 13th. The operations did not cause a soreness sufficient to interfere with his speaking and reading.

*Nov. 19th.*—A marked change in voice and speech—a deeper tone and clearer utterance. The boy's mouth is closed most of the time.

*Nov. 24th–29th.*—Great improvement. Resonance of the nasal cavity quite apparent, making a decided change for the better in his voice. On Feb. 7, 1885, the pupil could read a long sentence without a break.

From Nov. 3, 1884, to the middle of May, 1885, I gave the pupil a series of exercises which required action of the soft palate and the lips, and strengthened the nasal current of voice. The breathing exercises were given for the purpose of making use of the increased size of the opening and overcoming the habit of mouth-breathing. After Dec. 1, '84, the boy slept with his mouth closed.

## TOTAL REMOVAL OF AN IVORY EXOSTOSIS WHICH COMPLETELY FILLED THE EAR- CANAL.—RECOVERY.

By H. KNAPP.

THE subjoined communication, though being the report of one case only, may not be found devoid of interest, on account of the unusual difficulties and the complete result of the operation. The plan of the operation, which has proved successful in the removal of ivory osteomas from other localities, may, perhaps, be developed into a general, I do not mean exclusive, method for the removal of osteomas from the external ear-canal. The history of the case is as follows:

L. R., æt. thirty-eight, a Swede, had scarlet-fever when he was four years old, and from that time otorrhœa on both sides, with varying intensity, all his life. He is a strong, healthy man, free from any inherited or acquired dyscrasia. He consulted me first Dec. 18, 1872. He then had pharyngitis, polypi filling the left external ear-canal, perforation of the right *Mt*, and swelling of the adjacent walls of the canal. I removed a part of the polypi at once, and the rest, under chloroform narcosis, five days later. Small granulations, which showed themselves afterward, were treated with an alcoholic solution of sulpho-carbolate of zinc. The promontory was touched in both ears with a probe and felt normal. The discharge continued in both ears to a certain degree, his hearing was impaired, but he could attend to his business without difficulty. Three years later he consulted an aurist in Paris, who told him that nothing could be done for him. His hearing became gradually worse.

On Sept. 11, 1884, he came to me in great distress. For three days he had had the most intense pain in and around his right ear, radiating through the whole right side of his head, and depriving him of sleep. For three days the discharge from that ear had stopped. The right ear was filled with polypi, which I at once removed, and told him to put alcohol and boric acid in his ear. The left ear showed the same condition, but in a less degree, and it did not pain him. There were exostoses in both canals. Watch not heard.  $V R = \frac{1}{2}$ ,  $L = \frac{1}{8}$ .

The next day I found that the treatment had not diminished his distress. The pain was unabated. There was scant discharge in both ears. On careful examination it was discovered that the internal portion of the right ear-canal was completely filled with a hard, round tumor, of bony feel, covered with thin, red skin. Its broad basis was situated on the posterior wall of the canal, the rounded crest pressed against the anterior wall so firmly that not even a probe could be introduced between tumor and wall. On the upper and lower sides a probe could be forced in to a depth of a few millimetres. The eyes, examined with the ophthalmoscope, were found normal. The right mastoid process was neither tender nor red.

My opinion was that the mastoid, if not sclerosed by the chronic inflammation, was the seat of retained pus; in any case the secretion from the tympanic cavity was stowed back by the plugging of the ear-canal. To make an opening, by a drill or otherwise, and let the secretion out, was the immediate indication, but I thought the exostosis might be removed as well now as later, and the patient be spared the disappointment from half-measures. He, seeking relief from his excessive headache, willingly consented.

The operation was done at the N. Y. Ophthalmic and Aural Institute, Sept. 12, 1884. As soon as the patient was etherized—which took three minutes—I made with a scalpel an incision through the skin, along the posterior wall of the canal, corresponding to the base of the tumor. Hard bone was laid bare. The incision was made wider by dissecting off the adjacent skin. I applied a very sharp, small chisel to the base of the tumor, hitting it with a mallet in order to find out whether the tumor was attached to the bone by a base of softer bone substance. This is not infrequently the case in osteomas of the orbit and its neighboring cavities. I applied the chisel along the whole base of the tumor, close to the osseous wall, from which it sprang not

quite abruptly, and hammered for some minutes, but the tumor did not yield. Then I chiselled a groove into the tumor at its base. This brought the dense ivory structure of the growth to view. The progress into the depth that I made in this way was discouragingly slow. I therefore divested the whole anterior surface of the tumor from its integument, and chiselled a portion of the superior and inner periphery of the tumor off. I could now introduce probes and small hooks behind the tumor. Availing myself of the space gained, I put the bent portions of different hooks behind the tumor and tried to move it forward. All those instruments broke. I made an attempt to grasp the apex of the tumor with Sexton's foreign-body forceps. A branch broke off like glass. Patiently I chiselled deeper into the tumor at its base until a solid piece (*a* in figure on page 126) about the size of a large pea was removed. The whole basal portion, however, was left. Though the canal was now open again, I concluded to remove also the basal portion and restore the whole calibre of the canal.

In removing the broad and very hard basal portion, *I no longer attacked the tumor, but the tissue in which it originated*, chiselling into the bone of the ear-canal. This bone proved less dense than the tumor, and I made far better headway. After some time the mass could be slightly moved with a strong pair of forceps. I continued chiselling around it, posteriorly, above, and below, until I could, not without considerable force, twist out a solid piece of dense bone to which a portion of the bony canal was attached. This cleared the canal, but its walls were ragged and rough to a large extent, also where the instruments had not touched. The whole posterior wall was bare.

During the operation the canal was frequently syringed with a warm solution of boric acid and wiped out with absorbent cotton-wool. After the operation, when the hemorrhage, which was very moderate all through, was arrested, some boric-acid powder was put in the canal and covered with absorbent cotton. The patient had considerable pain at night, both in the wound and his head. There was no swelling, no irritation, but the ear discharged a great quantity of thick, somewhat offensive, evidently old pus.

During the next days the pain continued, the discharge diminished; there was no swelling. Iodoform was put into the canal. September 23d, eleven days after the operation, the patient left the hospital. The condition of the wound was good, he had no



fever, but his headache was still present, though not quite so intense.

At the front of the wound rough bone became the starting-point of vigorously spouting polypi, which I had to scrape out every three or four days. This caused considerable pain, but as soon as the news of the discovery of the anæsthetic action of cocaine reached New York, Oct. 11, 1884, I used it in his ear—dropping a 4 % solution on the granulations—and the scraping, now almost painless, could be done much more thoroughly.

Five weeks after the operation a piece of necrosed bone was removed from the posterior wall, and two weeks later another one, together with the malleus, of which the tip of the manubrium was missing. These pieces of bone (*c* and *d*, figure on p. 126) had been the starting-points of the granulations; they had been loose for some weeks, and were easily drawn out. When the last came out it was followed by a large quantity of thick pus, and a free opening led into the cavity of the mastoid process in which the pus had been stowed up.

From that day the patient was free from his stunning headache, and said he was another man. There were no more granulations. He was directed to syringe his ear with a weak solution of boric acid, or corrosive sublimate ( $\frac{1}{1000}$ ). He came to see me from time to time, and attended regularly to his business. The discharge continued moderate.

Feb. 2, '85, there was still a deep depression in the bone, filled with pus.

The condition of the left ear had considerably improved. When the patient came to see me, Sept. 11, '84, on account of the headache and pain in his right ear, I examined the left ear also and found two mamillary exostoses, the larger on the anterior, the smaller on the posterior wall. They touched each other near the centre, leaving a small space in the upper part free. There was some purulent discharge, and the skin of the meatus was swollen. This was the ear with which the patient could understand people when they spoke directly to him while he was pressing the auricle forward. He could not hear the watch. This ear was syringed twice daily with a solution of boric acid. Feb. 2, '85, there was scarcely any discharge from that ear, the skin was no longer swollen, and he could understand my voice across the room ( $V = \frac{2}{8}$ ). With the right ear the hearing for the voice was  $V = \frac{8}{8}$ .

I had not seen the patient for some time, and was surprised that in the right ear-canal, near the tympanic cavity, *a membrane had formed that stretched transversely, at right angles, through the canal.* It was a continuation of the skin lining the canal, was smooth, slightly red, and had a central round aperture about 3 mm. in diameter. Touched with a probe, it was elastic but firm, and when I introduced a cotton-holder, mounted with some cotton, through the aperture, I met with a bony resistance (promontory) about 5 or 6 mm. behind the membrane. Withdrawing the cotton-holder, the membrane was drawn forward, and the little cotton plug, which came out with a click, had dipped up some mucus in the tympanic cavity. In a few days the central opening in the diaphragm had become larger; I again dipped some mucus up, and directed the patient not to syringe his ear, but to wipe it out with cotton wound on a match, if there should be any discharge. There was none, and when the patient, some weeks later, came to see me again, *the transverse pseudo-membrane had disappeared without a trace, just as mysteriously as it had put in an appearance.* The canal was of normal width, and lined everywhere with healthy skin. The inner wall of the tympanic cavity lay open to view, the *Mt* being absent. The mucous membrane was red, but not thickened. During syringing the water ran into the throat.

May 5, 1885.—Conditions materially the same. Still a little discharge from the ears. They show the effects of bad weather. No pain;  $h = \text{R}$ , (watch of 24 inches hearing distance heard when pressed against the ear, also from mastoid and temple). L E, the same, but fainter. Tuning-fork heard through the air, and through the bone from every part of the skull. With a flexible tube the lowest whisper is heard;  $V = \frac{3}{8}$  each ear.

July 22, 1885 I asked the patient to let me examine him again. The condition was materially the same. He had suffered from the excessive heat we had had at that time. In his right ear the hearing was  $V = \frac{3}{8}$ —, *i. e.*, I had to raise my voice somewhat to be understood at 20'; in the left  $V = \frac{1}{8}$ ;  $h = \text{R}$ . (pressed on the ear), from mastoid and temple the same, fainter in L than R E.

#### REMARKS.

1. The size of the *pieces of bone* are given in the accompanying drawings in their natural dimensions.



*a* is the ivory exostosis which projected into the canal and was first chiselled out.

*b*, the basal portion of the exostosis with that part of the osseous wall in which it originated.

*c* and *d* are portions of dead bone which were situated in the mastoid cavity, at the side of the exostosis.

*e*, the malleus, without the tip of the handle, such as it was exfoliated.

2. The *pathogenesis* of the case is clear. Chronic otitis media had led to periostitis, caries, formation of polypi, and exostosis in the course of thirty-four years. When the exostosis in the right ear occluded the canal completely, the secretion was kept back, and the symptoms were those of retained pus in the mastoid. The local changes of the mastoid were, however, so insignificant that I thought the tympanic cavity was the chief locality of the retention. Moreover, I thought that it was more likely that the mastoid in the course of years should have been sclerosed, especially as there was so marked a new formation of bone in the canal. The history of the case showed that I was mistaken. Two pieces of dead bone were situated on the anterior side of the process, near the posterior wall of the ear-canal. These pieces, before necrosis took place, must have been carious, and given rise to the formation of polypoid granulations on the one hand and to hyperostosis on the other, a process with which we are all familiar.

3. If I had been able to make a correct diagnosis, I would have *operated* in an entirely different way. I would have chiselled the mastoid open close to the insertion of the auricle, which would have given me access to the sequestra.

Through the same opening not only the sequestra, but the exostosis might have been removed.

4. If we are not sure of the presence of mastoid disease, or if an operation shows that the mastoid is sclerosed and an operation for exostosis becomes necessary, a hole bored through the bone with a dentist's drill, as Mathewson and a few others have done, may afford immediate, and perhaps permanent, relief, but when the radical removal of the exostosis is intended—which seems to me more desirable in most cases,—I would do it from the beginning in the manner in which I removed the basal portion of our specimen, namely, by attacking the mother tissue, which is softer than an ivory osteoma. There is no particular danger in breaking down a part of the osseous wall of the ear-canal. The only vulnerable neighborhood is that of the glenoid articulation. This will, however, rarely come into question, as exostoses seldom spring from the lower wall. The frequency of the origin in the posterior wall evidently points to mastoid disease as the primary affection.

5. The removal of the exostosis under consideration was one of the most difficult operations I have ever performed. I am somewhat familiar with the difficulties in removing osteomas from the orbital and nasal cavities and from the frontal sinuses, but they are surpassed by those in the ear-canal on account of the narrowness and darkness of the field in which we have to operate. It took me an hour and twenty-five minutes to complete the above operation, but the result, I think, was a brilliant reward of my patience and perseverance. As far as I have perused the literature of the subject it seems that almost all operations undertaken for the removal of exostoses from the ear-canal have not been completed. It remains to be seen whether the method of sub-periosteal enucleation, so brilliantly inaugurated by Maisonneuve for these tumors in the nasal cavity, and successfully applied by myself to the frontal sinus, could not be made available also for the extirpation of exostoses in the ear-canal.

## A MALFORMATION OF THE EAR.

By C. TRUCKENBROD, OF HAMBURG.

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(With four illustrations on plate ii.)

MALFORMATIONS of the ear have long since claimed the attention of observers. Lincke, in his text-book on otology,<sup>1</sup> has made a careful collection of all the cases observed up to his time. He mentions none, however, similar to the one I am about to describe. More recently Schwarze<sup>2</sup> has given a complete summary of the malformations thus far reported. On page 31, under the head of defective formation of the external auditory canal he writes: "Complete absence of the auditory canal occurs with absence or an undeveloped condition of the auricle, and with congenital defect of the drum-membrane." The case is described in *v. Ammon's Zeitschrift für Ophthalmologie*, vol. v., p. 4.

Graunitz<sup>3</sup> also describes a case which bears a striking similarity to ours. He states (p. 454) that Mrs. Buthke had a marked obliquity of the face, causing considerable disfigurement, existing from birth, or at least as long as she could remember, and accompanied with an imperfect development of the auricle on the left side and complete closure of the

<sup>1</sup> Vol. i., p. 582. Leipzig, 1837.

<sup>2</sup> "Pathological Anatomy of the Ear," in "Klebs' Manual of Pathological Anatomy," vol. ii., part 2. Berlin, 1878. Translated into English by J. O. Green, of Boston.

<sup>3</sup> Contribution to the Study of the Depressions at the Base of the Skull.—*Virchow's Archiv*, 1880, vol. lxxx., p. 449.

corresponding auditory canal. The autopsy showed a well-developed right auricle; the left was small, with a very large helix projecting forward. The antihelix and scaphoid fossa were wanting. The lobule was divided into two parts by a cleft.

Behind the very small articular fossa for the lower jaw and in front of the mastoid process is a somewhat depressed surface of bone, showing a row of small grooves for vessels; but no trace of an auditory canal exists. These grooves lead to large mastoid cells, which occupy the place of the external meatus. The middle ear is very small; it communicates with the pharynx through the Eustachian tube. No drum-membrane can be recognized. Of the small bones, the stirrup is quite normal, the incus pretty regular; to it is attached by a bridge of bone a small rudimentary malleus, recognizable only by means of a lens. The cochlea and semicircular canals are normal. The inner auditory canal opens into a large cavity.

Cock<sup>1</sup> describes a case of congenital dilatation of the tube, its lumen being three or four times the normal.

In our case the malformation was right-sided, and even from a casual examination of the face it was to be seen that some failure in the development of the side of the face and skull had occurred. The patient, a woman of sixty-three years, for æsthetic purposes, always kept one half of her face covered. According to her statement, she had never heard the slightest with the right ear. She had once come under treatment for severe epistaxis, on which occasion the defect was observed. She died suddenly after a sickness of two days.

*Autopsy* revealed: Chronic endocarditis of mitral valve. Cardiac hypertrophy. Emphysema and brown induration of the lungs. Venous congestion of kidneys, spleen, and liver.

The petrous bone was sawed away and its examination resulted as follows: The right auricle (fig. 1) is pear-shaped, the thick, clubbed end directed downward, the pointed part upward. The helix is seen as a swelling running from

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<sup>1</sup> *Medico-chirurg. Transactions*, London, vol. xix., p. 161.

below upward; its length, 4 *cm.* Above, it ends in a somewhat rounded club-shaped extremity. A rudimentary antihelix can be made out. The tragus is a conical projection, 0.5 *cm.* high. The antitragus is not well marked. The lobule itself is a thick, shapeless swelling, bearing only a remote resemblance to the normal structure. It is 1.2 *cm.* in height and thickness; in breadth, 0.5 *cm.* The concha proper is a spherical cavity, the entrance to which is a long slit-like cleft, having a vertical direction. The cleft is at the same time somewhat curved in the shape of an S. Its height is 2.5 *cm.*; its breadth, 0.3 *cm.* The depth of the cavity is 1.5 *cm.*; its greatest diameter (vertical) measures 2.7 *cm.*, its horizontal diameter 1.5 *cm.* A small diverticulum, measuring in depth 0.3 *cm.*, and in width 0.4 *cm.*, extends from the lower part of the cavity. The cavity has no other extensions, and is formed exclusively in the cartilage. This cartilage may be regarded as the cartilaginous part of the external ear. Of an osseous auditory canal (external) there is no trace. The whole mass is fastened to the squamous portion of the temporal bone by connective tissue. The connection is not so firm as to prevent moderate movements in any direction. The entire auricle was carefully dissected and removed from the bone. In searching for possible remnants of the external auditory canal or drum-membrane, a vessel (fig. 2, *a*) of medium size was found running in the direction of the zygomatic process. On tracing its course, it was found to pierce the bone and run along the upper aspect of the petro-squamous fissure. The fissure itself showed a small groove for the reception of the vessel. With the vessel, strong bands of connective tissue extended through the fissure to the outer surface of the bone.

Kirchner has drawn attention to the practical importance of this vessel on account of its liability to be involved in inflammatory processes or in injuries. Before him, Zuckerkandl also had described this anomaly (of 280 skulls occurring in 22), and had remarked the developmental relations of its formation. According to Kölliker,<sup>1</sup> this

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<sup>1</sup> "Elements of Embryology," 1880, p. 371.

vascular connection between the outer surface of the temporal bone and the interior of the cranium is constant in the embryo and disappears later on. The persistence of this anastomosis, which may exist in the fully developed temporal bone, as Luschka has shown, reminds one of the condition of the embryo in which the original transverse sinus penetrates the cranium at the place in question, the aperture becoming closed later on, and the internal jugular vein springing from the lower extremity of the primitive jugular.

Moos has shown that in phlebitis and thrombosis of the lateral sinus, the persistence of this anomaly may be the occasion of œdema in the temporo-zygomatic region.

The articular surface of the temporal bone for the lower jaw is very flat; there is no posterior articular process. The stylo-mastoid foramen is present (fig. 2, *b*), and also the Glaserian fissure, through which strong bands of connective tissue extend into the tympanum. The mastoid and styloid processes are well developed.

The Eustachian tube (fig. 3, *a*) is present. It has a very large, quite uniform lumen. Its vertical measurement, where it opens into the drum cavity, is 4 *mm.* An isthmus proper does not exist as the tube measures 2 *mm.* in diameter at its narrowest (the junction of the long and cartilaginous parts). The entire length of the tube is 2.4 *cm.*, of which 1.4 *cm.* belongs to the bony part. The tensor tympani muscle exists; its tendon is attached by a broad extremity to the malleus and incus. The tympanic cavity appears as a considerable expansion of the extremity of the tube. It is 6.5 *mm.* high, 9 *mm.* long, and 3 *mm.* deep. The examination of the tympanum showed no trace of the drum-membrane. Solid bone is found in the normal situation of the membrane. The stapedius muscle is present. Its tendon is inserted into the stirrup at the normal site. The mucous membrane of the tympanum is somewhat thickened. The stirrup is firmly fastened to the oval window by connective-tissue bands which allow of scarcely any perceptible movement. Its shape is quite normal (fig. 4, *a*), but stretched between the crura is a thin,



firm, bony plate. The incus is present, its two processes being very short and rudimentary (fig. 4, *b*). Ossiculum Sylvii present, attached to the head of the stirrup. Of the malleus, only the head exists. Its articular surface is united to the incus by bone, the joint being absolutely immovable. The bulb of the jugular vein is very large. The sigmoid sinus is present. A vein which connects the transverse sinus with the veins of the middle fossa passes through the front part of the upper border of the petrous bone, at a distance of 8 *mm.* from the squama. The superior semicircular canal is very prominent, greatly projecting into the interior of the skull. The cochlea and membranous semicircular canals are normal.

## CEREBELLAR ABSCESS IN CHRONIC PURULENT OTITIS—EXTENSION ALONG THE FACIAL NERVE.

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Peter Wanoth, æt twenty, employed in a foundry in Upper Silesia, was admitted to the hospital on October 6, 1884. On admission, he complained only of severe headache in the vertex, said to have lasted fourteen days. An otorrhœa had existed for five weeks, according to his report. His statements were not reliable, however, on account of the blunting of his mental faculties.

He understands moderately loud words uttered near the ear. The right auditory canal shows nothing out of the way. On the right side the drum-membrane is entirely destroyed, and the tympanum is filled with a mass of small polypi, deeply situated among which is a pulsating drop of secretion. The amount of secretion is trifling. The facial nerve, so far as it supplies the muscles of the brow and lids, is paralyzed. Patient states the inability to close the right eye has existed eight days. Still, no obliquity of the uvula is to be made out, nor is there any loss of power in the muscles of the soft palate, a circumstance which is worthy of special notice in consideration of the results of the autopsy. The fundus of the eye is normal, not even a marked hyperæmia being observed. Temperature  $38.5^{\circ}$ ; pulse is strong, regular, rather frequent; after removal of the polypi so far as they could be reached by the snare and evacuation of the secretion by catheterizing the tube, *the patient can close the right eye almost completely.* In the further course of the disease, the fever was inconsiderable.

The temperature rose once to 39°, but after two doses (2 grammes) of antipyrin, fell to the normal, leaving the patient comfortable and quite free from the distressing headache. There was some constipation, the abdomen was hard and retracted, the patient felt dizzy on sitting up, and several times passed urine involuntarily. The discharge of pus from the right ear was very profuse from the day of his admission.

On Oct. 11th the stupor increased, a mild delirium supervened, followed on the morning of the 12th by sudden stertorous breathing, complete loss of consciousness, divergent strabismus, light convulsions of the upper extremities, pulmonary œdema. Death occurred on the same evening. On the preceding day some patches of herpetic vesicles appeared on the right cheek. On the day of the death the right cheek was dotted over with them.

The AUTOPSY was made thirty-six hours after death.

The description of the right temporal bone, which was removed for a later and more careful examination, is given below.

The dura mater was much congested, and attached by exudation to the pia in a few spots; otherwise it was normal. There was purulent lepto-meningitis, especially at the base, beginning in front at the chiasm and extending posteriorly to the envelopes of the medulla. A few small stripes of exudation ran up on the convexity along the vessels of the pia mater. The anterior portion of the pia, on the lower aspect of the right cerebellar hemisphere, is of a dirty green color. In the right cerebellar hemisphere, and partly also in the lower vermiform process, are two abscesses, of about the size of a walnut, filled with greasy pus. They communicate with each other, and are surrounded by a thick capsule. The anterior of the two reaches quite to the fourth ventricle, the ependyma of which is somewhat thickened and marked with small points of blood. The lateral ventricles are moderately enlarged and contain turbid serum. The descending crura of the fornix are soft. Nothing further of interest in the present case was noted in the brain.

The examination of the right petrous bone gave the following results:

The drum-membrane completely destroyed. The cavity of the tympanum is filled with masses of polypi and with greasy pus. The polypi extend into the mastoid antrum through an opening 6 *mm.* in diameter. The mastoid process, which is markedly prominent externally, has a sclerosed wall 15 *mm.* thick. The above-mentioned cavity in the mastoid is situated immediately under the posterior fossa of the skull. The tegmen tympani is pretty thick, and shows slight caries on its lower surface only. Of the ossicles there is no trace; the chorda tympani is also destroyed. On the inner wall of the tympanum the fenestra ovalis is completely open. The facial nerve runs in a curve backwards and downwards along the inner wall of the cavity of the tympanum, in which it lies perfectly free. There it is neither thickened nor congested, whilst from the gangliform swelling to the internal auditory meatus it is much thickened, and has a reddish-gray discoloration. The Fallopian canal is in its entire course filled with pus, which flows from the internal meatus. The acoustic nerve is intimately united with the facial for the whole length of the inner auditory canal, and presents the same morbid appearances. The vestibule and cochlea contain a moderate amount of pus. The spaces in the diploë of the petrous bone are, especially in the posterior portion, filled with greasy pus.

**Remarks.**—A continuous line of suppuration can be traced with certainty from the tympanic cavity along the facial nerve into the posterior cranial fossa, and thence below the pia mater to the cerebellum, and the abscess situated in it. Although there was an open road for the passage of pus through the fenestra ovalis (found open on autopsy) into the vestibule, and thence to the internal meatus, the consideration of the varying intensity of the morbid process at these various points makes me incline to the view that the pus followed the track of the facial nerve. It seems to me very probable that there was a predisposition to extension of the disease in this way, due to a very great, if not complete, congenital defect of the bony canal, which surrounds the nerve as it skirts the tympanum, since there were no considerable

gross signs of caries along the course of the facial in the tympanic cavity.

It is especially worthy of note that, contrary to the ordinary view, the muscles of the palate were not paralyzed, although the inflammation of the facial nerve was most marked centripetally from the gangliform swelling.

That the site of the headache is of no account in localizing a supposed brain-abscess, is also shown by this case, in which the pains were always referred to the vertex.

In conclusion, we would remark that several days before death the right tympanum was washed with a warm solution of common salt through the catheter, as a result of which some of the fluid must certainly have found its way through the open road into the inner ear, if not into the cranial cavity; yet no evil results followed either immediately or for some days.

## TWO CASES OF SEVERE DISEASE OF THE LABYRINTH, COMPLICATING SCARLATI- NAL DIPHTHERITIS.

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THE analysis of the following two cases presents some points which have not been clearly described in the existing literature on the subject ; in fact there is scarcely an instance of scarlatina-otitis accompanied by severe disease of the labyrinth reported, in which the otitis has been watched from the beginning by an aurist. Before reviewing the present literature on the subject, I will proceed to describe the course of the affection in two cases that have fallen under my observation.

FIRST CASE.—*Severe scarlet-fever, complicated with diphtheria of the nasal passages and the post-nasal pharynx. Extension of the diphtheritic process to the middle ear by the Eustachian tubes. Complete loss of hearing.*

Willie Sch., 6½ years of age, previously healthy, came down with scarlet-fever Feb. 1, 1882. Mother died of tuberculosis three years previously. Father healthy.

I was called in consultation with Dr. Heinrich Rehn Feb. 7th, on account of pain of the right ear complained of by the patient. The nasal passages and the post-nasal pharynx had been covered with a diphtheritic membrane for two days, the cervical glands were greatly swollen, and the nose was discharging an offensive purulent fluid. The scarlatinal eruption was still present, the patches were confluent on neck and chest, and dark red like

petechiæ. Fever still high. Pulse 116 to 120. Temperature between 40° and 41° C., accompanied by great prostration and slight somnolence.

Examination of the ears disclosed the following conditions : Walls of the bony part of the external auditory canal of the right ear relaxed, œdematous, and excoriated. The membrana tympani was swollen and softened. Hearing much reduced.  $h = \frac{1}{2}$ . On the left side the hearing (as nearly as could be determined) was slightly below the normal ; the left membrana tympani, however, showed no abnormality. Measures were immediately taken to arrest the further progress of the disease. The right *Mt* was freely incised. The incision showed the membrane to be thoroughly softened. After much trouble I succeeded in introducing the smallest size Eustachian catheter through the very narrow nasal passage, and finally, in forcing a little air into the ear, and through the opening in the *Mt*, a small amount of thin secretion was driven out of the tympanic cavity. Liq. ferri sesquichlor. was given internally, and a weak solution was used to syringe out the ear and nasal cavities ; a weak solution of carbolic acid was also used to wash the nasal passages and ear, and boracic-acid powder was blown into the external auditory canal.

On the next day (Feb. 8th) the left side was also markedly affected. Examination showed a macerated condition of the *Mt*, closely resembling the appearance of the right *Mt* on the preceding day. Hearing was so much diminished that the patient could not hear the loud voice, in close proximity to the ear. The child was very restless during the night. Fever very high. Morning temperature 41. 2° C. Pulse 130 and very small. Paracentesis of the *Mt* sinistra was performed, and air was forced through the ear by use of the Eustachian catheter. The secretion, which was small in amount, resembled very closely that found in the other ear—thin, serous, inoffensive. On inspection and by use of the probe the tissue of the external auditory canal was found to be soft and spongy, and the mucous membrane of the tympanic cavity was transformed into a spongy, purulent mass. During the first five days the secretion changed from a serous to a purulent character. The general condition of the little patient was very critical from the 9th to the 12th of February. The petechial eruption remained unchanged, swelling of the cervical glands increased, purulent masses were constantly discharged from the nose and pharynx, and food was taken with great difficulty. The body

temperature sank to between  $40^{\circ}$  and  $41^{\circ}$  C., with the pulse at 120 to 140. Three days after the beginning of the ear trouble the child was completely deaf; no sound could be heard. Patient complained of sounds in the ear, unaccompanied by pain; these, however, were of a purely subjective character. The treatment consisted of instillations of boracic acid, with weak solutions of liq. fer. sesquichlor. and carbolic acid, used alternately for cleansing the parts. The ear was inflated by the use of the Eustachian catheter, and the passages cleansed with the disinfecting solutions twice daily,—a very troublesome procedure, not without danger to the operator, as masses of membrane were forcibly and frequently ejected. At a later stage the mastoid processes were painted with tr. iodine.

The mucous membrane of the tympanic cavities gradually cleared up and began to throw out granulations. I removed numerous granulations from the left side with my sharp spoon. In the fourth week the discharge ceased almost entirely. When it became possible to obtain a view of the tympanic cavities, I found that the lower half of the right *M* was gone; three fourths of the left had also disappeared. The ossicles were present in both ears; the little patient was totally deaf and remained so. In the third week of its sickness, the child appeared to hear the singing of some birds, which gave us some hope of an ultimate partial recovery; these sounds, however, were purely subjective. All conceivable methods for testing the hearing—such as tuning-forks, table-bells, whistles, etc.—were employed, but no perception of sound remained.

After desquamation had set in, the improvement in the general condition of the patient was rapid; in the sixth week the child was permitted to leave the bed. The gait, however, was unsteady, and this, together with a tendency to fall forward, persisted for some weeks. At the end of twelve weeks, these symptoms had disappeared; no defect remained in nose or pharynx.

At the beginning of May, Prof. Moos had the kindness to come to Frankfort, to consult with me in the case. We concluded to try injections of pilocarpin, but could not do so, as the father of the child opposed any further attempts at a cure. The child was now enjoying the benefits of the teaching at a neighboring institute for deaf-mutes, and had fully recovered his speech, which, for two months after his sickness, had been almost wholly lost.



**SECOND CASE.**—*Severe scarlet-fever, with diphtheria of the post-nasal pharynx. Extension of the diphtheritic process, per tubam, to both tympanic cavities. Recovery of hearing after injections of pilocarpin.*

Cath. B., aged seven years, of healthy parents, was taken sick with a severe form of scarlet-fever, on Dec. 20, 1882. According to the report of Dr. Credener, of Hanau, who was treating the case, severe symptoms rapidly supervened on the commencement of the attack. The eruption speedily became confluent in a number of places, and was dark red in color; pharynx coated with a diphtheritic membrane; cervical glands swollen. The body-temperature ranged between 40° and 41.5° C. for eight days. Prostration great, accompanied with slight somnolence. Salicylic acid was the principal medicine given. The pharynx was pencilled with a disinfecting solution, and old wine was administered to the patient frequently. On the 4th of January I was called to Hochstadt in consultation. At this time the diphtheritis was receding, only a few small plaques were to be seen on the fauces; nasal passages free; strength of patient improving. The child, however, had been totally deaf for eight days. The affection of the ears had proceeded without much pain; annoying subjective sounds only had been complained of. A thin, offensive secretion, small in amount, had been discharging from the ears for three days.

Condition of the ears on Jan. 4th: A thin secretion containing pus and detached shreds of epidermis was present in the external auditory canal of the right side. The lower half of the *Mt* was absent; the handle, denuded of periosteum, appeared free in the opening. The mucous membrane of the tympanic cavity was brownish-red in color, swollen, and covered in places with a yellowish membrane.

The left ear presented nearly the same appearance. However, the loss of membrana tympani was not so great, and the handle was fully covered. The watch could be heard from the temple and in contact with the auricle; tuning-fork large C° from mesocranium doubtful. C' and A' could not be heard either from mesocranium or from the external meatus; loud voice could not be heard either. The parents said that the child heard nothing, and that they were compelled to communicate with him by signs.

The air douche could be used in this case without difficulty, both tubes were again freely open, and the air passed through the openings in the membrana tympani of both sides freely.

As the heart action was again strong, and the strength of the patient was thought to be sufficient, I concluded to try injections of pilocarpin.

The treatment was begun by injecting 0.005 gram. under the skin of the neck, twice daily, increasing the dose by 0.001 gram. every two days until the maximum, 0.01 gram., was reached. A few minutes after each injection a half glass of sherry was administered. A solution of boracic acid and a two-per-cent. solution of carbolic acid were used alternately to syringe the ears with, and the mastoid processes were painted with tr. iodine twice daily. The air douche was applied once daily.

The physiological effect of the pilocarpin was complete, profuse sweating and copious salivation followed each injection. I noticed, as early as the third day, that an increased secretion from the tympanic cavities accompanied the profuse sweating and salivation, eventually becoming so copious that it dropped from the ears. I consider this effect of the pilocarpin in this case of great signification. The old school of medicine would, undoubtedly, have regarded this as the "crisis" of the disease. It was fully six days before the first perception of sound was noticed. The fact that perception of the higher tones was the first to return was of physiological importance, as indicating an advanced injury to the labyrinth. On the 14th of Jan. the child complained that the singing of the canary bird in the room with him had wakened him, and although he was formerly very fond of the bird, begged to have it removed. He said that the noise made his ear ache—a hint that we should be very careful in testing the hearing of patients suffering from disease of the labyrinth, and should not permit loud noises to be constantly produced near the ears. On Jan. 15th the patient appeared to understand single words; this seemed to please him very much. The head was apparently freer; he began to play, the appetite increased, and a healthful flush suffused his cheeks. Subjective sounds were now seldom complained of. From Jan. 20th on, a 0.01-gram. injection of pilocarpin was made every two days only. About thirty injections had been made up to this date, and the hearing in the right ear was so much improved that the watch, in contact, could be heard, and conversation at two metres could be under-

stood. At this time subjective sounds were very infrequent. The ability to distinguish sounds in the left ear was still very slight.

Vertigo and trembling were so intense shortly after the commencement of the disease that the child could not hold its head erect without assistance, and had to be supported when taking its food. After six or eight injections of pilocarpin the child could sit erect, but at the time of leaving the bed (seven weeks after the fever began) the child possessed the "duck gait" to a high degree, with an inclination to fall forward and to the left side. The waddling gait did not disappear until the eighth month after the commencement of the disease, remaining four months longer than did the reeling gait in Willie Sch., the first patient. The various subjective sounds also remained much longer in this case than in the first.

From the 30th of Jan. to the 17th of Feb., nine injections of pilocarpin were made; the injections were then discontinued. The tr. of iodine applications had been stopped some time before. The condition of the right tympanic cavity improved much more rapidly than the left. By the 22d of Feb. the discharge had ceased, and cerumen began to be secreted. Insufflations of boracic acid was the last medication employed.

A large number of granulations sprang from the post. wall of the left tympanic cavity, and were removed with the snare at two different times, April 10th and May 28th. On the 21st of July I chloroformed the patient, and removed the carious tissue with my sharp spoon. After this no more granulations appeared. The hearing of the left ear did not come up to that of the right from the first, still, at the beginning of April, loud conversation could be heard at two metres; at the same time, however, whispered conversation could be heard at four metres by the right ear, and the ticking of the watch could be heard at 4 cm.

In the fall of '83 his private teaching could be resumed, and the child advanced so rapidly in his studies that he was enabled to attend school early in 1884, at which time he could understand his teacher very easily. On account of the great defect in each *Mt* the hearing was somewhat disturbed, and of course did not reach the normal. In Sept. of '84 the subjective symptoms had disappeared.

**Remarks.**—In regard to the nature of the disease, there can be no reasonable doubt that in both of these cases we

had to do with a diphtheritic process of the middle ear, plainly communicated, *per tubam*, from the post-nasal pharynx. In the case of Willie Sch., the mucous membranes of the nose and pharynx were completely covered with the diphtheritic membrane when first examined, the right tube was impermeable, the mucous membrane of the tympanic cavity and the *Mt* dextra blanched and softened. Thirty-six hours later the diphtheritic process had passed through the tube and had invaded the tympanic cavity on the left side. In Cath. B., isolated plaques were still visible in the fauces; a similar coating also covered the mucous membrane of the tympanic cavities in the parts that were visible. As before stated, the diphtheritic process was receding when I first saw the last case, and the disease was not of so severe a nature in this as in the first case.

The anatomo-pathological changes concerned in the production of the deafness in the case of Willie Sch., offer a wide field for discussion. The opinions of Dr. Moos and myself were at variance. Moos believed that the injury to the nerve-endings in the labyrinth was produced by exudation alone, without perforation of the *membrana fenestræ*, and he based his hope of a good result from the use of pilocarpin on this hypothesis. I was of the opinion, taking into consideration the rapid destructive changes in the tympanic cavities, that the delicate *membrana fenestræ* had been perforated, permitting an escape of the fluid contents of the labyrinths, and that no improvement was to be hoped for from the use of pilocarpin. The subsequent history of the case favored the latter hypothesis. Complete deafness supervened inside of sixty hours, the subjective sounds disappeared in a few days, and the reeling gait and vertigo disappeared in about two months. In the case of Cath. Br., these persisted at least six months longer.

When we recollect that vertigo, or inco-ordination, is produced by irritation of the nerves of the *ampullæ*, and disappears on destruction of these nerves, we must conclude that a rapid destruction of these nerves was brought about by escape of the fluid contents of the labyrinth, while in the case of Cath. Br. the *membrana fenestræ* remained in-

tact, as the diphtheritic process was probably not so severe on the post. wall as in other parts of the tympanic cavity. It is probable that in the last case we had to do with an exudation into the labyrinth, which, for the time, abolished the function of the nerve. This would account for the long duration of the affection, the annoying subjective sounds, and, we may suppose, the improvement brought about by the absorbent effect of pilocarpin. That the labyrinth in the case of Cath. Br. was severely affected, scarcely admits of doubt. Disease of the sound-conducting apparatus alone would not completely abolish the perception of sound through the bones of the skull, as was the condition in this case. C' and A' tuning-forks were not heard by bone-conduction, large C° doubtful; the loud voice could not be heard. The return of the hearing, first for high notes (warbling of the canary), argues greatest injury, or embarrassment, to that part of Corti's organ lying next to the fenestra and occupying the first turn of the cochlea.

In regard to the prognosis, these cases show very clearly that if the diphtheritic process has invaded the tympanic cavities, we must be cautious in giving an opinion as to the results. In the case of Willie Sch. the disease involved the sound ear, and in less than thirty hours, in spite of energetic treatment, produced total deafness. In the last case the hearing was, in large part, recovered by the treatment employed, in spite of the fact that total deafness had existed for eight days.

What the peculiar effect of the pilocarpin was is hard to determine. Were the membranæ fenestræ perforated, or was the labyrinth indirectly affected? The appearance of the serous secretion from the tympanic cavities was certainly a very favorable sign. Possibly a decrease in the tension of the labyrinth, and a rapid elimination of the scarlatinal poison, brought about by the great increase in the various secretions, explains the effect produced by the pilocarpin. That we must take into consideration the condition of the heart and the possibility of collapse, in the use of pilocarpin, has been pointed out by the older observers, who have recommended its use in the treatment of diphtheria in

general. Stimulant in the form of good wine is to be recommended, at the time of giving the injection. Pilocarpin should be used in every suitable case, as early as the heart-action and general condition of the patient will permit. In the case of Willie Sch., the danger from the use of calabar bean, in the first two weeks, would have been considerable on account of the great prostration; and later, after extensive destruction of the nerve had taken place, the treatment would have produced little or no improvement.

It remains now to take a short survey of the literature on otitis diphtheritica. Wreden<sup>1</sup> was the first to state that numerous cases of otitis diphtheritica were produced by simple extension of the diphtheritic process from the post-nasal pharynx by way of the Eustachian tube. Wendt,<sup>2</sup> as a result of a number of sections, saw the continuation of the membrane from pharynx along the tube to the tymp. cavity in but one case. Küpper<sup>3</sup> describes a case, as early as 1876, in which he found the tube and the tympanic cavity filled with a croupous exudate. Katz<sup>4</sup> has also reported a similar case. Heidloff<sup>5</sup> goes so far as to state that all cases of otitis media, complicating scarlet-fever, can be referred to the diphtheritic infection.

A. Burckhardt-Merian inclines to the opinion of Heidloff when he says<sup>6</sup>: "We are certain that all those severe and dangerous forms of otitis media, accompanying scarlet-fever, depend on the direct transmission, *per tubam*, of the croupous or diphtheritic process taking place in the pharynx."

Moos and Steinbrügge<sup>7</sup> are not decided as to whether the disease in the tympanic cavity occurs independently of the process in the pharynx (in the two cases that they observed, during life), or whether the process is communicated to the tympanic cavities by way of the Eustachian tubes, as they failed to secure the cartilaginous portions of the tubes *post mortem*.

Cases in which we find cicatricial tissue in the tubes, following severe scarlatinal otitis, as mentioned in a previous

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<sup>1</sup> The numbers refer to the bibliography at the end of the paper.

paper by me,\* go to prove that the process extends by way of the tubes. On the other hand, I have often observed otitis during scarlet-fever, in which the severe form of the disease was obviated by closure of the tube, occasioned by the inflammatory action in the pharynx.

Gottstein,\* in his essay: "Beiträge zu den im Verlaufe der acuten Exantheme auftretenden Gehöraffectionen," says that the important question in affections of the ear accompanying the acute exanthems and the infectious diseases, as to whether we have to do with an extending inflammatory process, or whether the ear affection is due, directly, to the specific poison, can only be satisfactorily determined by carefully observing the cases from the beginning; and the opportunity to do this is seldom afforded us. He describes a case where he saw the patient on the fifth day after the commencement of the ear trouble; the hearing, which probably had not been completely abolished, had improved to a certain degree.

The case of Willie Sch. is entitled to careful consideration, as I was fortunate enough to observe the progress of the disease from the very beginning, and for a long time made two examinations daily.

Blau<sup>10</sup> has described a case which, in many particulars, corresponds with the first case reported in this paper. The patient was a child of seven years, in which an otitis media diphtheritica developed on the eighth day of an attack of scarlet-fever. Complete deafness followed eight days after the otitis began,—much slower than in my case. Dr. Blau saw the case, for the first time, fourteen days after the beginning of the otitis, at which time both tympanic cavities were seriously affected. Complete facial paralysis occurred about the twentieth day of the attack; this was probably produced by perforation of the membrana fenestræ, followed by otitis purulenta labyrinthi, and as panotitis, involving the Fallopian canal. Twelve days after the facial paralysis had developed, Wilde's incision was made, the ear cleansed, and relieved of a mass of purulent débris. By this procedure the pressure on the nerve was removed, and the paralysis gradually disappeared; the nerve-endings in the

labyrinth were, however, destroyed. Moos<sup>11</sup> has described the pathological changes present in the labyrinth in a similar case. He found an infiltration of small cells, and a suppurative process of a high degree affecting the membranous saccule, the ampullæ, and the semicircular canals. This process was so far advanced in the cochlea, that the finer elements of Corti's organ could not be distinguished.

An interesting feature in Blau's case was, that twelve days after the disappearance of the diphtheritic process in the post-nasal pharynx and tympanic cavity, it appeared on the auricle, extended into the external auditory canal, and again invaded the tympanic cavity. Blau argues from the above, in opposition to the views of Burckhardt-Merian, that diphtheritic infection of the middle ear may take place by other routes than by simple extension from the pharynx by the Eustachian tubes. The history of my case causes me to favor the views of Heidloff and Burckhardt-Merian; however, I cannot take the stand that diphtheritic infection of the middle ear cannot take place through other channels than by simple extension from the pharynx *per tubam*. Blau also says: "There is no doubt that many cases of otitis complicating scarlatina are of a diphtheritic nature, and the number recognized will be larger in proportion as we have the opportunity of observing the affection from the beginning."

During the last eighteen years I have myself observed from the beginning (aside from the two cases reported above) many cases of otitis accompanying scarlet-fever, from the simple catarrhal otitis to the most severe forms of diphtheritic panotitis, and have grouped them into three classes.<sup>12</sup> I am of the opinion that the so-called diphtheria of scarlet-fever, as usually employed, indicates, in reality, the severer form of scarlatinal infection only. Paralysis of the pharyngeal muscles seldom or never occurs as a sequela of this so-called diphtheritic process.

It must be admitted that the general condition of the patient influences largely the tendency to complications in scarlet-fever; "lymphatic" children, those who show a tendency to glandular enlargements, and whose parents are



sufferers from chronic diseases, being the ones most easily affected. In such patients the thinness of the walls of the vessels affords but a slight barrier to the passage of the specific poison.

As to the indications for the use of pilocarpin and the manner in which it affects these cases," Moos, at the close of his recent article," seems to coincide with the views adopted by me in the two cases described above, particularly that of Cath. Br. Undoubtedly very beneficial results may be obtained by the judicious use of pilocarpin, when we become acquainted with the precise indications for its exhibition.

As this article goes to press I am observing a case of otitis diphtheritica, which occupies a middle ground between the two cases just reported, and which will be a fitting supplement to this. I shall endeavor to report this last case at a very early day.

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## PANOTITIS IN SCARLATINA-DIPHTHERITIS.

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IN the following I give the description of an additional case of scarlatinal otitis, which now, after more than five months, can be regarded as accurately enough determined to complete the disease-picture drawn by the two cases described by me in the preceding paper. I have designated the disease in the title as panotitis, inasmuch as the tympanic cavity, mastoid process, and labyrinth must be regarded as simultaneously diseased.

THIRD CASE.—*Scarlatina-diphtheritis with panotitis of both sides.*

Emma v. E., æt. four years, previously healthy, and a blooming, rosy-looking child, but with very delicate, thin skin, and light-blond hair. Was taken sick on Dec. 15, 1884. The mother of the patient had suffered now and then in her childhood from glandular swellings, narrow nasal passages, and subacute otitis; the mother's brother also; during the last four months the child had had frequent attacks of coryza, without, however, showing any impairment of hearing. On the first day of her sickness there was only a slight angina. On the second day distinct scarlatinal eruption. On the fourth day the temperature rose from 39.6° to 40.2° C. (103.3–104.3° F.), and diphtheritic membrane appeared, advancing from the naso-pharynx to the arches of the palate; on the sixth day considerable impairment of hearing (the first symptom of ear disease). On the seventh day I saw the patient for the first time in consultation with my colleague, Heinrich Rehn. The child had been very restless during the night, chiefly

on account of high fever ( $39.6-40.3^{\circ}$  C.), which was not influenced particularly by three one-gramme doses of antipyrin. The little patient lay indifferent with mouth wide open and gave no answer to the questions asked her. It could not be determined whether the ability to perceive speech was still present or not. In both auditory canals were cast-off shreds of epidermis, and a little thin, discolored, fetid secretion. Both tympanic cavities were filled with whitish-yellow, partially organized masses of diphtheritic exudation; drum membranes completely destroyed. When the nose was syringed out (with solutions of carbolic and boracic acids) yellowish-white masses of membrane, tightly rolled up, were evacuated from the naso-pharyngeal cavity. Politzer's method was employed, and the stream of air whistled through the holes on both sides. After this some improvement appeared, and in the afternoon the head was freer; the child had spoken some sentences. Pulse 120, evening temperature  $40.1^{\circ}$  C. The eruption still continues, but shows only the usual scarlet redness and is not petechial in character. Maxillary glands moderately swollen; urine not very copious, but free from albumen. Patient drinks a great deal, but takes absolutely no nourishment. Ordered liq. ferri sesquichlorat. internally.

*Dec. 22d.*—Patient was very restless during the night. Anasarca of both eyelids, of the hands and feet. Urine light-colored, copious, and without albumen. On syringing out the ears partially organized, diphtheritic masses were again removed. Over the left mastoid process was a painful swelling. Patient still appears to understand loud speech, and heard a dog bark in the yard. Morning temperature  $39.6^{\circ}$  C.; evening,  $40.3^{\circ}$  C. Pulse 130.

*Dec. 23d.*—As an experiment 0.005 gm. of pilocarpin muriate was injected under the skin of the neck. Two hours afterward there was moderate perspiration, with great restlessness and oppression.

*Dec. 24th.*—The injection of pilocarpin cannot be continued on account of the weak condition of the little patient. A deep Wilde's incision had to be made over left mastoid process, by which about two teaspoonfuls of fetid bone-pus was evacuated. Drainage. Also from both auditory meatuses I removed with my sharp spoon fatty-degenerated granulation masses. On the left side, on the posterior wall of the tympanic cavity and auditory meatus, appeared an extensive spot of denuded bone. The gen-

eral condition in the evening was somewhat better. Vertigo is not so marked, for the child can now sit up straight alone. Acuteness of hearing uncertain. Pulse 120. Temperature 39.2-39.8°C.

*Dec. 26th.*—Yesterday evening there was again high fever. Patient very restless during the night. On the left side there was erysipelas, reaching from the region just back of the ear to the middle of the cheek. Very fetid pus discharged from the wound of incision. Yet for the first time I succeeded in washing it out thoroughly, so that the boracic-acid solution injected into the tympanic cavity with a pretty forcible stream flowed out from the incision wound. The probe disclosed the fact that the bone was extensively denuded of periosteum.

*Dec. 28th.*—Naso-pharynx freer; only a little diphtheritic membrane removed. Swelling of face beginning to diminish; erysipelas subsiding; the latter was probably caused by retention of fetid pus in mastoid process. Morning temperature, 38.5°C.; evening, 38.6°C. Pulse 100. Some appetite.

*Dec. 29th.*—Anasarca no longer present. Urine abundant, without albumen. Inspection of the ears reveals the following:

Right: mucous membrane of tympanic cavity dark red; three fourths of drum membrane destroyed; the handle of the hammer entirely denuded of periosteum, light-yellow in color, projects freely into the opening; process of incus not visible.

Left: mucous membrane of tympanic cavity dark red, but less loosened; somewhat smoother than the right. Almost all of the membrana tympani is gone; the manubrium mallei, denuded of periosteum, projects freely into the opening, as also the long process of the incus which appears to stand remarkably straight. Perhaps a loosening of the stapes, and with it of the movement of the chain of ossicles has taken place.<sup>1</sup> The child now speaks distinctly, and also swallows more easily since the swelling of the pharyngeal mucous membrane has also subsided.

*Dec. 30th.*—The erysipelas has disappeared: the incision in the mastoid looks healthier. In syringing, the water circulates freely through the mastoid antrum, and flows out through the incision; secretion less fetid.

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<sup>1</sup> This supposition is further supported by the marked retraction of the handle of the hammer, established at the close of this observation. In consequence of the cicatricial contraction, especially marked in the posterior section of the tympanic cavity (formerly profuse granulations sprang from this vicinity) the long process of the incus, loosened from its connection with the stapes, could rise somewhat, together with the malleus, and deviate upwards and backwards.

*Dec. 31st.*—Evening temperature  $39.2^{\circ}\text{C}$ ; somewhat elevated again on account of a recent gastric disturbance. Patient is unsteady, showing, when seated, a tendency to fall towards the right side. Weakness and loss of appetite still very considerable. The acuteness of hearing cannot be determined since the child does not give direct answers at all. On account of the weakness of the little patient the use of pilocarpin had to be discontinued.

*Jan. 3d, 1885.*—General condition better. No vertigo when sitting up.

*Jan. 8th.*—Restless during the night on account of pain in right ear. Periostitis of right mastoid process is beginning.

*Jan. 10th.*—Right: Wilde's incision, and evacuation of almost a teaspoonful of fetid *bone-pus*; irrigation through the antrum now succeeds as formerly on the left side.

*Jan. 13th.*—Submaxillary glands of left side again much swollen. Ordered ungt. pot. ioidid.

*Jan. 14th.*—Appetite good. Appearance of incision also good. Child is lively. Voice smooth and melodious, as formerly; the little one, in relating a story, changes the modulations of the voice, according as to whether she personates, in talking, a man or child. I endeavored now, above all, to determine the acuteness of hearing, in order to discover the condition of the sound-perceiving apparatus. The further therapy, of course, had to be made dependent upon the result of this examination; I had to determine especially whether the use of pilocarpin, formerly stopped, should be resumed, now that the strength of the patient had so much increased. But the examination of the acuteness of hearing offered unusual difficulty in this case. This difficulty consisted, on the one hand, in the previous education of the child, who, as the teacher said, had hardly ever given direct answers, even during perfect health. She always had spoken of herself in the third person, as, for example, "somebody hears," instead of "I hear." On the other hand, on account of fear, she invariably gave me affirmative answers to all my questions, inasmuch as she had, naturally enough, become very much afraid of me on account of my various therapeutical measures. If I asked her a question, the little patient always nodded her head in the affirmative. I requested the mother and teacher, therefore, to write down all words which she should subsequently speak. After some days, I had the pleasure of being able to determine the following: High consonants, especially the sound "S," were heard; "*nass*,"

"wasser," were afterward pronounced. The light, weak sound of "F," on the other hand, was in no case perceived. Instead of "Fuchs" was heard "Uchs," and consequently the little patient could not be made to understand what animal in the picture-book was meant. Also the word "König," especially the sound of "K," she did not appear to hear.

*Jan. 15th.*—The child, of her own accord and for the first time, says: "My ear rings." From now on the subjective tone-perceptions appear stronger; she asks, for example, "whether papa has been playing the 'cello'"; also says: "It sounds in my ear like a railroad."

*Jan. 23d.*—Secretion less copious on both sides, and more tenacious. Granulations are springing from the wall of the right tympanic cavity. Nevertheless, with Politzer's method, the air still streams freely through. Left: The denuded manubrium seems to be getting covered with a profuse crop of granulations; also the process of the incus.

*Jan. 25th.*—First attempt to walk. The child says: "I am dizzy."

*Jan. 26th.*—Second attempt to walk; she staggers in a marked manner after a few steps.

*Jan. 28th.*—After repeated attempts to walk (the first and second attempts did not allow of an exact examination) there is noticed a distinct tendency to fall to the right. The subjective perceptions of tone (music, conversation) are now quite intense, especially about noon, after drinking a little old wine, which she uses as a tonic. The general condition is much improved; the child is very lively, and sings various songs.

*Feb. 4th.*—The words "*Bor*" and "*Rhabarber*," which the child formerly did not know, are now spoken by her. Various other questions, however, are not correctly understood. On applying the large C<sup>0</sup> fork to the cranium<sup>1</sup> the patient says, "one hears music"; with A<sup>1</sup> fork, "it ticks"; while the sound of a high pipe C<sup>6</sup> is plainly unpleasant to her. The child was now put before the piano. She touches the different keys with pleasure: with the deep tones she says, "one hears music"; in the middle register, "one hears nothing"; while she again hears the high notes.

Inasmuch as it seemed probable from all the symptoms which have been described, that there was still present considerable dis-

<sup>1</sup> The examination of the hearing with tuning-forks very seldom gives a positive result in young children.

turbance in the sound-perceiving apparatus, it was decided to resume the use of pilocarpin, formerly suspended. Nevertheless the parents wished beforehand the advice of Prof. Moos, who was called in consultation Feb. 6th. We were essentially of the same opinion, and decided to continue the pilocarpin injections.

*Feb. 6th*.—Fistulous opening over the mastoid process. Right closed. Patient complains very much of subjective noises. "It goes clap! clap! in my ears." As it was impossible, for other reasons, for the parents to remain here in the hotel any longer, the family moved to Heidelberg, and Prof. Moos took charge of the further treatment, especially of the administration of pilocarpin treatment.

*April 6th*.—I saw once more the little patient in company with Prof. Moos, in Heidelberg, while passing through there. The membrane lining the tympanic cavity was less swollen, partially cicatricial in character. The manubrium and process of incus, in both ears, seemed to be again covered. The understanding of speech considerably increased; she repeated a number of words distinctly; she did not hear the weak "F" sound at all, for example she called me "Doctor Wol," while she had nevertheless never heard my name correctly, since I had never spoken to her previous to her becoming deaf from scarlet-fever. Also distant noises and rumbling on the street were heard. At this time, about 26 pilocarpin injections had been made, and they were still continued, twice a week, and were well borne. The child was fresh, lively, looked healthy, and was very talkative.

**Remarks.**—In the introduction to this case I said that, standing in a certain sense in the middle, it formed a supplement to the two formerly described cases. The form which Willie Sch. (Case 1) had presented had been the most injurious in its results; after little more than forty-eight hours there was total deafness, early loss of subjective perception of sound, early alteration of the sound of his own speech; after three months no more uncertainty of gait, although the visible changes in the auditory apparatus were not of so high a degree as in E. v. E. (Case 3), in whom a speedy destruction of *membrana tympani* and of periosteum in various places, especially of the chain of ossicles, and of both mastoid processes could be demonstrated at the beginning of the eighth week of the disease. The voice of this

child was unchanged in its melody ; the acuteness of hearing for a number of tones doubtful ; the subjective perception of sound still intense ; locomotion, without a guide, still impossible on account of attacks of vertigo. It can be well supposed, therefore, that the membrane of the fenestra, was still intact in the child, but that at the same time disturbances in the function of the nerve apparatus existed, which could gradually disappear.

In Catharine Br. (Case 2), the labyrinth was in the beginning in a similar condition, but, as the diphtheritic process began to subside much sooner, and the labyrinth was speedily relieved, the one half of the drum-head remained, and the mastoid processes were not involved ; the improvement in the hearing accordingly followed sooner and to a more considerable degree, beginning with the reappearance of subjective perceptions of tones.

The PROGNOSIS in such cases will always be extraordinarily difficult, so much the more perplexing for the physician, as the anxious parents ask almost daily, and wish to have encouragement. It seems to me that the question is very essential, whether a loosening of the articulation of the stapes and incus has taken place in consequence of the latter being denuded of its periosteum. In E. v. E. this seemed to me not improbable, at least in regard to the left ear. If with every sound the stapes makes an unlimited pendulum movement and oscillation, there must arise from this an exceedingly inexact perception of sounds on the one hand,<sup>1</sup> while on the other hand, it is conceivable that in the beginning attacks of vertigo can be excited during walking, on account of the calling forth of greater movements of the stapes, which can be by degrees eventually overcome by habit, and also by the formation of scar-tissue, and the new fixation of the stapes. The vertigo in such cases, therefore, need not be always referred to a disease of the labyrinth.

So far as the therapeutics are concerned, all those cases show us that the means known to us are not able to oppose the

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<sup>1</sup> Compare the determination of sound perception in loss of malleus and incus in the author's "*Sprache und Ohr*," pp. 150-165.



injurious operation of the diphtheritic exudation, even in the first few hours of the ear trouble. Masses of partially organized exudation appeared in the tympanic cavity, and that, too, in the most delicate parts ; if we had now instilled a 10-per-cent. alcoholic solution of salicylic acid, it would have remained for the most part on the upper surface of the exudation without availing any thing, even if it had really reached the tympanic cavity, while on the other hand, if it had reached a vulnerable spot, it could have caused even a rupture of the fenestra membrane. We must, in my opinion, in such cases, refrain from attempts to influence the diphtheritic process itself, and be satisfied with emptying as quickly and completely as possible the tympanic cavity of exudation, and ought only to resort to disinfecting means that do not corrode.

By the use of pilocarpin injections in the first place we are enabled to loosen more easily and effectually the diphtheritic exudation, and at the same time the labyrinth is speedily relieved, especially by the marked increase of the secretion of the mucous membrane of the tympanic cavity. But this treatment is very much interfered with, and that, too, at the height of the disease, by the somnolence and tendency to cardiac weakness induced by it, with no inconsiderable danger to the life of the patient ; one should, therefore, begin very cautiously, with very small doses of this medicine, and only after careful examination of the general condition.

### **Supplement.**

BY DR. S. MOOS.

Under the application of alcohol, healing by formation of scar-tissue (very delicate connective-tissue scars) had already taken place on the right side by the end of April, and an adhesion of the handle of the hammer (very much thinned in its middle third) with the promontory. In the middle of May there still persisted on the left side a scanty secretion from the red and still thickened mucous membrane of the labyrinth wall ; the handle of the hammer was

also on this side drawn towards the promontory, and only posteriorly could a beginning cicatrization of the opening in the membrana tympani be detected.

Forty-one pilocarpin injections were made altogether, from Feb'y 8th to May 1st. The first twenty-five were of a one-per-cent. solution, the last sixteen of a two-per-cent. solution. The strengthening of the solution was necessitated, because the desired diaphoresis diminished as the strength of the patient increased. At the end of March the little patient showed an increase of body-weight of almost one kilo. (2 pounds), notwithstanding frequent and excessive perspirations. In the beginning I made the injections daily, then every other day, then twice a week. The medicine was laid aside entirely only when vomiting commenced to appear regularly after the injections, which was the case in the last six. I could the sooner dispense with the medicine now, inasmuch as the walk of the patient began to be much surer, her fund of words increased, the most diverse musical tones were well distinguished; and before the completion of the treatment, the little patient declared, without being asked about it, that she heard a strong-ticking watch (10 metres hearing distance) louder between the teeth, and against the head, than she had formerly heard it in the ear.

# EXAMINATIONS OF THE AUDITORY ORGAN OF SCHOOL-CHILDREN.

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(With four plates of curves and three wood-cuts.)

AS in other departments of medicine, so in otology the need is felt ever more urgently to study the forms of disease not only in their anatomical and physiological relations and their etiology, but also to learn their frequency and prevalence among the total population.

There is no lack of statistical reports on the number of ear patients coming under treatment; and Bürkner,<sup>1</sup> in a collective synopsis of the statistics of ear diseases, recently published, was able to enumerate twenty-five authors who have given us, partly in a series of annual reports, statistical communications about the relative frequency of the ear diseases which had come under observation. I myself have made five reports, each of them comprising three years, about all the ear patients, 7,537 in number, which I have seen in a practice of fifteen years.<sup>2</sup>

Such reports may furnish information as to the relative frequency of the various forms of disease, their prevalence at different ages, in the two sexes, the influence of occupation, seasons, etc.; we may learn from them also that ear diseases must be of frequent occurrence, but they give

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<sup>1</sup> Beiträge zur Statistik der Ohrenkrankheiten.—*Arch. f. Ohrenheilk.*, Bd. xx., p. 82.

<sup>2</sup> *Aeratisches Intelligensblatt*, 1872, Nos. 40 et seq.; 1875, Nos. 26 et seq.; 1878, Nos. 44 et seq.; 1881, Nos. 26 et seq.; 1884, Nos. 49 et seq.; and *Arch. f. Ohrenheilk.*, Bd. xxi., p. 221.

us no answer to the question which is to be placed at the head of all others: How great is the prevalence of ear diseases in the total population? What is their *absolute* relation of frequency? The approximate estimate by v. Tröltsch, expressed by him in his text-book as early as twenty years ago or more, that in middle life, between twenty and fifty, at least *one* among every three men can no longer hear well and normally in *one* ear, corresponds nearly with the experience of all otologists. However, this is only an approximation, and it was of interest, not only to physicians, but generally, theoretically, and practically, to make it statistically certain by examinations of large numbers.

A numerical statement as to the occurrence of defective hearing among recruits is given by Trautmann,<sup>1</sup> who found 2.02 per cent. of defective hearing among 2,327 men. This number, however, is much too small, because Trautmann, owing to the rapidity with which the work must be done, could examine only those who reported somewhat deaf on inquiry.

As may be seen from the reports of all otologists, even childhood furnishes quite an important contingent of ear patients, and Bürkner, in the above-mentioned collation of reports, found that children up to the fifteenth year of life constituted a percentage of 22.2 of the grand total. In my last triennial report, just issued, I count among 3,846 ear patients 20.5 per cent. children to the fifteenth year.

Experience having taught me that a large number of ear diseases found in adults may be traced back to affections recovered from in childhood, I felt impelled to reiterate in every one of my reports how important therapeutical measures are, especially at that age; and the question had long ago occurred to me how large might be the absolute relative frequency of diseases of the ear in childhood.

The first examination of school-children was made by W. von Reichard<sup>2</sup> at Riga; it comprised 1,055 children between

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<sup>1</sup> Ueber den Werth der Ohrenheilkunde für die Militärärzte.—*Arch. f. Ohrenheilk.*, Bd. vii., p. 103.

<sup>2</sup> Ueber die Bedeutung eines guten Gehöres für die Schulbildung, W. v. Reichard, Arzt des Städtischen Gymnasiums zu Riga.—*Petersburger med. Wochenschr.*, No. 29, 1878.

seven and fifteen years. Unfortunately he tested the hearing power with the watch only. There were 22.3 per cent. who could hear only at 20-0 feet a watch which was heard by others at 20-60 feet and beyond; the defect was nearly uniformly divided among the sexes. About the diseases to which the defective hearing is due there are no statements contained in the paper, which enumerates chiefly lack of cleanliness and exposure to cold, aside from diseases of childhood, as the reputed causes of their frequency.

For more comprehensive and thorough examinations of the hearing of school-children we are indebted to Dr. Weil,<sup>1</sup> of Stuttgart, who tested 5,905 children for their hearing distance by means of whispered speech, and also determined the diseases present, by otoscopical examination. In some schools there were more than thirty per cent. who could not hear whispered speech at 8 metres, the hearing distance of which for the normal ear is 20-25 metres.

Besides, there are on record two smaller series of examinations by American otologists, Samuel Sexton<sup>2</sup> and Morrell,<sup>3</sup> the former of whom tested 570 school-children, among whom were 261 colored children; the examination, it is stated, could be performed superficially only, and showed 76 cases, or 13 per cent., of greatly impaired hearing power. The latter reports on 491 children, of whom 72 showed bilateral and 53 unilateral, together 25 per cent., diminished acuteness of hearing.

Little as these results can be directly compared with each other, partly because they were made with varying acoumeters, partly because different demands were made of the normal hearing distance, still they all prove that defective hearing in childhood is sufficiently prevalent to deserve our full attention.

It cannot be the task of any one person to collect sufficiently large statistical material for the solution of this question, and even my examinations, which I have continued with school-children for more than a year, comprise

<sup>1</sup> Die Resultate der Untersuchung der Ohren und des Gehöres von 5,905 Schulkindern.—*Zeitschr. f. Ohrenheilk.*, Bd. xi., p. 106.

<sup>2</sup> *Zeitschr. f. Ohrenheilk.*, Bd. xi., p. 333, and Bd. xii., p. 215. Review.

<sup>3</sup> *Zeitschr. f. Ohrenheilk.*, Bd. xiii., p. 236. Review.

only the proportionately small number of 1,918 children. If carefully executed, they require pretty much time, and I have laid greater stress on perfecting a uniform method, which might perhaps serve other investigators, than on very large numbers.

My examinations comprise three schools at Munich, viz., the alumni of the Ludwigsgymnasium, the so-called Holland's Institute; and two public schools, the former Common School II. A, and the Protestant School II. I am indebted to the principals of those institutions, not only for the permission to make the examinations, but also for their kind assistance.

In my first tests, made in Holland's Institute, I set myself the preliminary task to compare with each other our most generally used acoumeters—watch, Politzer's uniform acoumeter, and whispered speech—as to their applicability for examining large numbers, as has been done by Hartmann.<sup>1</sup> As I had at my disposal here intelligent young people, Latin scholars and college boys of from 10–18 years, I could expect more reliable statements than, for instance, in the lower classes of the public schools.

I chose for my examination an oblong dormitory facing the yard; because, containing a large number of beds and other furniture, it showed no material resonance of the walls, such as enters as a disturbing factor for tests of hearing in larger empty rooms. The dormitory was 15 metres long or, including the recesses of the doors, 16 metres, and 8 metres broad. In order to increase the distance, I utilized a dormitory adjoining the narrow wall and connected by a door, the frame of which, of course, deflected a part of the sound-waves. Owing to this fact, the upper limit of the hearing distance is rather too small, especially for whispered speech and probably also for Politzer's acoumeter, as will appear by comparison of the hearing distance for my whispered speech in the drilling rooms of the public school. As the examinations were usually made in the evening after four o'clock, when the other pupils were busy at their tasks, and the noises from without could not enter the room,

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<sup>1</sup> *Arch. f. Augen- und Ohrenheilk.*, Bd. vi., 2.

which was remote from the street, the quiet was as perfect as can be obtained during the day.

While testing the hearing for whispered speech and Politzer's acoumeter, the persons to be examined stood at one of the narrow walls of the dormitory, turning the ear to be tested toward me, the other being tightly closed with the finger; I moved along a line on the floor marked in metres, which extended through the door into the adjoining room. In the drilling rooms where I examined the other schools, I used the diagonal line, partly to increase the distance, partly to deaden the resonance of the walls.

During tests with the watch, both of us stood on the same line in the middle of the hall, and the person under examination had his eyes covered with a shade, so that I could convince myself, by holding my hand before the watch or covering the watch with it, to what extent the statements as to the hearing distance rested on self-deception, which was not rare, as I ascertained in this manner. It is necessary, too, that the person under examination lays aside his own watch.

Poltzer's acoumeter, as a rule, was at a sufficient distance to make it unnecessary to cover the eyes; the pupils were obliged to state the number of beats made each time.

The words employed in testing with whispered speech were exclusively the numbers from 1-99. They furnish sufficient variety to permit the formation of an opinion respecting the power of understanding speech generally. I also have convinced myself, especially during these examinations of large numbers, that we should by no means expect, in continuing to employ the same words, successively easier guessing. On the contrary, this fault, all the children knowing that they are tested for numbers, applies equally to all those examined, and hence can be disregarded. At all events, in using whole sentences, much more is liable to be guessed than with single words. Besides, it is found that certain words or numbers are not gradually guessed more easily on continuing the examination, but always some of their consonants are misunder-

stood or not heard at all by all the persons examined, until we have reached the limit of perception of the individual. It was these latter numbers which served mainly as the measure for ascertaining the limit of audition. Besides the number 100, which in proportion to all the other numbers is heard at too small a distance, it was the numbers 7, 5, 9 which were understood with the greatest difficulty both at the beginning and at the end of double numbers, and therefore always had to be interposed again between the other numbers. 5 (in German "fünf") and 7 are always mistaken for each other or for 6 until we are at the limit of audition; 5 as a rule is heard at a smaller distance than 7. Still smaller generally is the hearing distance for "neun" (nine); instead of it "ein" (in German pronounced "ine") is constantly heard by all until we reach the limit of perception. Only at the distance where "neun" at the beginning of a double number, as well as all the other numbers except "hundert" (hundred), were correctly repeated after several tests, I placed the limit for hearing whispered speech. The results were finally verified by the number "hundred"; where this is heard we can be certain that the distance is rather too small than too great; the understanding of this number can be no criterion, because, contrary to the others, it is comparatively easily guessed, as it alone contains the vowel *u*.

With the smaller children of from 6-7 years in the public schools I was forced to continue these tests for a pretty long time, until I obtained uniform results with the individuals. The children had to become used to the hearing of my organ, and partly also get more familiar with the double numbers. In testing with whispered speech I have taken special care and spared no time, because on its results are based all the examinations here following.

The results of the tests of 222 auditory organs examined in Holland's Institute according to the three methods, whispered speech, Politzer's acoumeter, and watch, are recorded in Table I. (p. 165).

They are, moreover, represented graphically in plate 1 (of vol. xv., Ger. ed.). The abscissas of this figure represent the



hearing distance expressed in metres ; and the height of the ordinates means the number of those hearing at the distance above given. The continuous line is the curve for whispered speech ; the broken line, for Politzer's acoumeter ; and the dotted line for the watch. If we consider first these curves, it appears by comparing them that the maximum for the normal hearing distance of whispered speech is much higher and more definite in form than that for Politzer's acoumeter, and still more so than that for the watch. The elevation of those having the best hearing for whispered speech rises to an ordinate of 67, and shows a more pointed form than that for Politzer's acoumeter, which rises only to an ordinate of 45 ; the decline is nearly uniform for both. The curve for the watch even shows two maxima separated by a hearing distance of two full metres, both of which rise only to the number 27 ; the rising as well as the falling of the curve is much more gradual. This relation of the three curves to each other we can interpret only to this effect, that the total results furnished by the examination with the watch are very much less definite than those obtained with Politzer's acoumeter ; but that the latter, too, is greatly exceeded in definiteness by whispered speech. We shall hardly err if we consider the result of this examination of large numbers as in the main applying to the individual.

An unavoidable error has arisen in the curves for whispered speech and Politzer's acoumeter by the fact that in Holland's Institute I had at my disposal a hall only fifteen metres in length ; while the hearing distance for the former, according to the results obtained by Wolf, Chimani, Hartmann, and others, is twenty to twenty-five metres ; and that for Politzer's acoumeter, according to Hartmann, fifteen metres, and still more according to Weil. As I, too, ascertained by these examinations, a distance of twenty metres is still too small to determine the upper limit both for whispered speech and for Politzer's acoumeter. The measurements for the watch are not affected by this error. However, that the former two curves, despite this error and the relatively small number of auditory organs examined in Holland's Institute, still give an approximately correct picture of the relation of

TABLE I.

HOLLAND'S INSTITUTE.

Hearing Distance of the Single Auditory Organs for Whispered Speech, Politzer's Acoumeter, and Watch.

Whispered speech is heard at metres .	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0.80	0.50	0.10
By . . . . .	13	20	67	26	16	15	20	4	9	2	4	6	2	2	1	5	3	2	2	1	2
Poltzer's acoumeter is heard at metres	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
By . . . . .	1	1	3	7	16	45	43	31	6	6	13	7	5	1	6	5	2	2	1	1	1
Watch is heard at metres	9	8	5	8	7	5	7	6	5	5	5	4	3	2	5	4	3	2	1	1	1
By . . . . .	1	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Total.	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222	222

TABLE II.

HOLLAND'S INSTITUTE.

Relation of the Hearing Distance for Whispered Speech to that for Politzer's Acoumeter and Watch.

Number of persons hearing at distances stated	13	20	67	26	16	15	20	4	9	2	4	6	2	2	1	5	3	2	2	1	2	Total.
Hearing distance for whispered speech in metres . . . . .	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0.80	0.50	0.10	Metre.
Poltzer's acoumeter is heard by the above	17.4	17.1	15.8	14.6	14.5	14.1	12.9	12	10.6	9.8	10.5	7.9	2.2	3.8	2	2.2	0.7	1.5	5	0.45	0.11	"
The watch is heard by the above	21	22	20	19	18	18.5	17	15	16.5	10	15	17	2.5	4	5	1.5	2.5	8	0.2	0.01	0.01	"
By the above	13	15	7	6.5	10	9.5	5.5	10	2	9.5	8	3	2	3.5	0.5	0.35	0.6	2	0.01	0.01	0.01	"
By the above	415.2	469.5	364.7	311.2	296.6	274.7	222.5	202.5	138.9	175	146.2	149.7	72.5	60	65	30.2	16	12.5	26	15	0.25	Cm.
By the above	800	900	650	550	500	450	350	325	550	175	300	350	75	70	75	35	15	42	0.5	0.5	0.5	"
By the above	150	200	60	100	110	100	100	200	50	175	80	60	70	50	10	6	10	10	10	10	10	"

the hearing distance of children, appears by comparing them with the other curves for whispered speech which I have obtained as the expression of the hearing distance of all the children examined, and which have resulted very similarly, only more definitely than the curve here found, corresponding to the larger number of children. If we inspect the curve there obtained and which is divided according to equal quota of the hearing distance, we shall see why the error for the first two curves of plate I, which is due to the insufficient size of the place of examination, does not materially affect the result.

In Table II. (p. 165) is recorded the relation of the hearing distance for whispered speech to that for the other two acoumeters, which I have obtained for the single auditory organs perceiving whispered speech each at a certain distance; namely, first, the average hearing distance for the watch and Politzer's acoumeter, which coincides with the respective hearing distance for whispered speech, and second, its maximum and minimum.

This table shows that a large number perceiving speech at an equal distance hear not only the watch—a well-known fact—but also Politzer's acoumeter at greatly varying distances. Thus, for instance, of 67 auditory organs which understood whispered speech at 16 metres, the watch was heard on the average at 364.7 *cm.*, maximum 650, minimum at 60 *cm.* Such great differences, of course, are not obtained with Politzer's acoumeter, at least with normal or approximately normal hearing. Only among the 5 pupils who perceived whispered speech at 3 metres is there a similar great difference between maximum and minimum as there is in the above example for the watch—that is, an average of 2.2, a maximum of 5, and a minimum of 0.5 metres. Among those hearing speech as far as 11 metres, the maximum and minimum for Politzer's acoumeter varies, with an equal hearing distance for speech, about in the proportion of maximum 3, and minimum 1; for the watch, however, between maximum 10 and minimum 1. It is noteworthy, besides, that those who heard the watch out of proportion badly, showed on an average a similar disproportion also for Politzer's acoumeter as compared with speech.

The comparative graphic representation of the hearing distances for the three acoumeters has yielded another advantage which is very essential to the appreciation of my total investigations. It gives us a generally useful measure for the sound intensity of my whispered speech. One glance at fig. 1 shows that the two curves for whispered speech and Politzer's acoumeter very nearly coincide in their course; that therefore my whispered speech is heard almost at the same distance as the Politzer acoumeter obtained from the optician Gottlieb, of Vienna, and which serves as a uniform measure. In this way the intensity of my whispered speech is determined, and every succeeding examiner in schools can in the same way determine, on a number of pupils, the relation of the hearing distance for his whispered speech to Politzer's acoumeter before entering on the proper examination of large numbers. In this way we shall also get absolutely comparable values for hearing tests with whispered speech. Lucae's<sup>1</sup> maximal phonometer, which is likewise intended to give a measure of intensity for speech, was not applicable for me, because the instrument purchased by me measures only the pressure of expiration employed for explosive consonant sounds, and shows but a minimal motion, or none at all, in words containing no explosive sounds, as particularly for the words "fünf, sieben, neun," which, as above stated, had to serve in our determinations as the numbers audible at the smallest distances.

Since O. Wolf<sup>2</sup> has found and determined the tones contained not only in the several vowels, but also in the consonants, and the relative proportional intensity of speech-sounds to each other, speech as a test for the hearing has become much more accessible to our judgment, and I believe with Wolf that, at least for the examination of large numbers, we shall look in vain for a better acoumeter which extends over an equal length of the scale and at the same time gives us information as to the perceiving capacity for the most variable noises, which it is absolutely impossible to do without, in a complete examination of the hearing.

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<sup>1</sup> *Arch. f. Ohrenheilk.*, Bd. vi., pp. 276 and 294.

<sup>2</sup> "Sprache und Ohr," Brunswick, 1871.

Some tone defects, of course, may escape us during the exclusive employment of whispered speech in testing the acuteness of hearing, and it would be a desirable addition if, besides, a complete tone scale, especially the upper part not contained in speech, were used in the test. Such completeness, however, is out of the question in school examinations which must not consume too much time. Besides, the number of ear patients in whom tone defects are demonstrable seems to be but small. Burkhardt-Merian, who has made extensive examinations in this direction and has reported thereon at the third International Otological Congress in Basle, kindly informs me on inquiry that among more than 700 tests in ear patients he was able to determine tone defects in 7 cases only—that is, less than one per cent. of the ear diseases.

In order to attain always an approximately equal intensity of my whispered speech, I have followed a very simple rule : In speaking I have used only the residual air remaining in the lung after an expiration which is not forced. According to my experience, this precaution suffices to render the whispered speech of the individual sufficiently uniform for testing the hearing. I have also endeavored, like Weil, to speak always in the same tempo.

In the two public schools I was able to use somewhat larger localities for the examinations, viz.: in the Common School II. A, the drilling-room having a diagonal of eighteen metres, and in the Protestant School II. likewise the drilling-room having a diagonal of twenty metres. In these rooms, too, the resonance from the walls, etc., was much reduced by the numerous utensils present. But few extraneous noises from without entered into these localities. The greatest disturbance I met with in the drilling-room of the common school, which is surrounded by gardens, was in the shape of the twittering of the birds, as the examination was made in the spring and summer. In the same place I became aware of another possible source of error. On a sunny day, when through the numerous windows a row of sunbeams fell across my field of examination, the results of the tests appeared to me remarkably poor, and this might perhaps be explained by

TABLE III.

## COMBINATION OF THE THREE SCHOOLS EXAMINED.

Hearing Distance for Whispered Speech of the Single Auditory Organs in Metres.

Age.	20 Mt.	19 Mt.	18 Mt.	17 Mt.	16 Mt.	15 Mt.	14 Mt.	13 Mt.	12 Mt.	11 Mt.	10 Mt.	9 Mt.	8 Mt.	7 Mt.	6 Mt.	5 Mt.	4 Mt.	3 Mt.	2 Mt.	1 Mt.	0 Mt.	Total.	
7 years .	Boys. Girls.	20 24	9 19	94 112	44 46	28 25	15 15	14 10	13 11	10 15	8 13	12 13	17 15	8 11	7 10	15 5	9 7	9 11	5 9	13 6		366 400	
8 "	Boys. Girls.	15 21	9 22	110 84	44 56	26 32	28 18	9 13	12 9	9 9	10 18	13 8	15 16	11 13	10 19	6 11	13 7	4 9	7 3	14 6	1 1	360 414	
9 "	Boys. Girls.	23 18	16 12	88 35	57 34	22 23	26 24	20 12	9 9	7 7	3 10	12 11	20 16	8 13	5 6	11 14	5 10	5 4	1 7	6 4	1 9	348 268	
10 "	Boys. Girls.	25 17	11 9	108 61	48 35	21 21	26 10	16 20	9 10	7 14	7 8	12 10	13 10	12 16	4 11	6 9	8 12	4 4	7 5	11 9	2 2	388 316	
11 "	Boys. Girls.	18 14	15 6	70 30	17 17	9 8	6 7	4 9	10 10	3 6	5 7	1 4	1 6	5 4	5 6	5 2	3 2	5 8	4 1	1 2	1 1	174 88	
12 "	Boys. Girls.	24 10	7 9	3 73	2 23	3 19	8 6	8 10	5 14	2 14	2 6	4 7	4 10	5 10	9 9	4 8	10 3	3 5	1 1	2 10		266 90	
13 "	Boys. Girls.	14 11	9 2	24 34	14 17	4 10	7 7	6 6	3 3	3 4	3 3	5 5	4 1	6 1	2 1	4 3	2 2	2 2	3 3	2 2		130 30	
14 "	Boys.	16					1	1	3	1	3	1	1	1	1	1						38	
15 "	"	24					2	4	1	2	2	1							3			24	
16 "	"	21					1	1	1										2			12	
17 "	"	9					1	2														14	
18 "	"	8						2															
Total . .		332	46	863	443	260	215	163	161	144	115	92	106	157	121	105	101	80	67	62	98	5	3,836
		1,341																					

a partial reflection of the sound waves by the variously warmed layers of air lying between me and the person examined. Thenceforward the shades were always closed on sunny days.

In Table III. (p. 169) I give a synopsis of the total number of auditory organs examined in the three schools. They are arranged, first, according to their hearing distance at 20, 19, 18, etc., to 0 metres; second, according to their age; and third, according to sex.

The number of those hearing at 20-16 cannot give us a correct idea of the average hearing distance of the normal ear, because in none of the three schools had I a sufficient distance at my disposal for the normal acuteness of hearing. Only the 641 children of the Protestant school could be tested up to a distance of twenty metres, and these too would, to a great extent, have understood my whispered speech still farther away. In the common school, where 1,166 children were examined, the distance was only eighteen metres, and in the dormitory used for the 111 pupils of the Holland Institute, only fifteen metres; for the examination at a greater distance through the open door could not give us satisfactory results. For this reason I have included in Table III. among the best hearing, and in the column for twenty metres, all those who in Holland's Institute could hear beyond fifteen metres, the limits of the hall.

In the Protestant school, too, where I could measure up to twenty metres, that distance, as will be seen from the special Table IV. (p. 171), includes by far the greatest number.

But we must assume that, if the upper limit of the hearing distance had been reached, the numbers would have decreased to the left as much as to the right, where there are those with successively worse hearing.

The results of the collective Table III. are represented in the curve on plate 2, in which those hearing at 20, 19, and 18 metres are brought together under the latter distance. This curve, as may be seen, is rather similar to, but more uniform than, that on plate 1 which was obtained for whispered speech from the 222 auditory organs in Holland's Institute.

TABLE IV.  
PROTESTANT SCHOOL II.  
Hearing Distance for Whispered Speech of the Single Auditory Organs, in Metres.

Average age.	Class in School.	20 Met.	19 Met.	18 Met.	17 Met.	16 Met.	15 Met.	14 Met.	13 Met.	12 Met.	11 Met.	10 Met.	9 Met.	8 Met.	7 Met.	6 Met.	5 Met.	4 Met.	3 Met.	2 Met.	1 Met.	0 Met.	Total auditory organs.
7 yrs.	Boys' class I.	20	9	8	4	7	5	4	3	6	5	2	6	11	4	4	3	4	2	1	2	—	110
8 "	Girls' " Ia & b	24	19	12	10	5	9	8	2	8	8	4	5	7	6	3	2	1	3	2	—	—	138
	Boys' " II.	15	9	5	7	8	12	4	8	7	7	2	4	7	2	4	9	2	5	3	8	—	138
9 "	Girls' " II.	21	22	5	7	14	5	4	6	2	1	3	4	3	1	5	1	1	—	—	1	—	106
	Boys' " III.	23	16	17	11	10	8	5	10	4	5	1	6	7	2	—	1	1	—	1	2	—	130
10 "	Girls' " III.	18	12	7	8	6	7	6	3	5	5	2	1	5	7	2	2	—	2	1	3	—	100
	Boys' " IV.	16	11	10	15	4	11	9	7	8	5	5	4	9	3	3	5	4	2	2	5	—	138
11 "	Girls' " IV.	17	9	9	5	7	7	5	3	4	3	1	4	7	9	4	3	4	2	1	—	—	104
	Boys' " V.	10	15	7	6	9	1	2	—	7	2	3	1	4	4	4	—	2	3	1	1	1	84
12 "	Girls' " V.	14	6	3	3	3	3	2	4	1	3	3	1	1	3	—	—	4	3	3	—	—	60
	Boys' " VI.	8	7	3	2	3	3	5	4	1	—	1	1	2	3	1	3	—	1	—	2	—	50
13 "	Girls' " VI.	10	9	7	7	5	3	3	1	4	6	2	3	1	2	2	1	2	1	1	4	—	74
	Boys' " VII.	11	2	4	9	3	6	5	3	4	3	—	4	2	2	2	—	—	—	—	—	—	60
Total,		207	146	97	95	84	80	62	54	64	53	30	44	68	45	34	30	21	23	16	28	1	1282



It shows a decline, at first very rapid, then successively slower, with only two small elevations, one with those hearing at 8 metres, the other with those hearing at 1 metre.

The first elevation finds its most probable explanation in small errors in measurement. Inasmuch as I counted those hearing at 8 metres or less among the pathological cases, which were entered on separate sheets, it may have happened now and then that, where the hearing distance was a little more or less, and the statements varied a good deal, I fixed the hearing distance at 8 metres.

The second small elevation at 1 metre, which comprises all those hearing whispered speech from 1 metre to directly at the ear, has for us a much more important reason. It is the expression of an error in the division we employed for Table III.—an inaccuracy which applies not only to this part of the curve, but to the curve in its whole extent. A simple reflection will show us that the relative length of the several abscissas in plate 2, which forms a graphical representation of the values in Table III., is not correct, and that this curve, therefore, can only give a distorted image of the true relation of the hearing distance in the classified ages examined. That this should be perfectly clear to us is of fundamental importance, not only for these measurements, but for hearing tests in general. An increase of the hearing distance from 1 to 2 metres does not indicate the same difference in hearing power as does an increase, for instance, from 24 to 25 metres. If we take the normal hearing distance for whispered speech at 25 metres, an increase from 1 to 2 metres means a doubling; an increase from 24 to 25 metres, however, only a rise of the hearing distance by one twenty-fifth. The more the functional capacity grows, the more the hearing distance approaches an infinitely large distance; the more it decreases, the nearer it comes to the value 0. Therefore, if we wish to divide the series of those hearing from 0–20 metres into equal quotas, this series must not be arithmetical as given in the table, but it must be geometrical.<sup>1</sup>

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<sup>1</sup> The author would have spared himself a good deal of reflection and would have presented the results of his examinations much more comprehensively, if he had adopted the method of recording the acuteness of hearing that expressed

Such a series we obtain in the most simple way if we start from the smallest hearing distance for whispered speech which can be expressed by measure, and let each succeeding higher quota of hearing distance double the value of the next lower one.

In this way I have arrived at the division in Table V. (p. 174) which represents merely another and more correct grouping of Table III.

Luckily I had exactly noted the hearing distance in centimetres with every one hearing at less than one metre—a circumstance found necessary in the compilation of this table.

I started from a distance of 0.03 metre, which represents about the smallest distance at which whispered speech can still be tested. The last column received those from  $\frac{1}{32}$ —0, that is, those who could no longer understand whispered speech at all, but only loud speech, or not even the latter with the respective ear.  $\frac{1}{32}$  is to be interpreted with reference to whispered speech, and means that the latter could be heard but not understood. The next column comprises those hearing whispered speech between 0.03 and  $\frac{1}{32}$ . In the succeeding column above is each time found the double distance, 0.06–0.03, 0.12–0.06, etc. In the fifth column from the left, 0.25–0.12 was chosen instead of 0.24–0.12, in order to gain farther upward simple figures in metres. The distances corresponding to the equal auditory difference, grow of course, very rapidly toward the end; the last column but one comprises all those hearing between 16–8 metres; the last, all those hearing beyond 16 metres, and thus *includes all those with normal hearing, because the limits of this column extend from 16–32 metres*. Thereby, too, the error is nearly eliminated which was caused in Table III. by the varying length of the halls. Only in Holland's Institute the normal cases had to be counted from 15 metres, because this was the length of the hall; while in the other two schools we drew the limit at 16 metres, but this is of so much the less

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the degree of impairment of hearing as a fraction of the normal standard. This method, devised by Snellen (and now universally adopted) for recording the acuteness of vision, has been in general use in America for more than ten years.—H. K.



consequence as most of those there tested could still understand through the open door.

According to Vierordt's experimental investigations "on the weakening of sound when propagated through the air,"<sup>1</sup> the intensity of sound when heard through the air does not decrease in the proportion of the square of the distance from the source of the sound, which appears to be a necessary physical postulate, but sound intensity and distance stand in a simple inverse ratio. Accordingly, we must assume as approximately equal in extent the quotas of perception placed in juxtaposition in my Table V. in the several columns; of course this would be strictly correct only if the examinations had been made in the open air. In a closed space Vierordt found the relation determined in the open air confirmed only with very weak sources of sound; the more intense the source of sound employed in a closed space, the slighter was the decrease of the intensity of sound with increasing distance, reflection from the walls gaining correspondingly in importance. For this reason we may consider as actually equal in Table V. only the quotas of perception in the columns of those hearing at small distances; while with the increase of the hearing distance the reflection from the walls enters more and more as a favoring factor for an increase of the hearing distance, and hence the quotas of perception toward the normal hearing distance must in reality be assumed as successively smaller.

In order to show how uniform are the results of the examinations in this natural system of division, I subjoin here in Tables VI., VII., and VIII. the several schools in the same division as in Table V. which is composed of them.

Very remarkable to me was the result of the graphic representation—the curve plate 3—which was obtained from Table V., the same as the curve plate 2 was obtained from Table III.

While in the latter curve we have found the above-mentioned two elevations, this new curve shows an almost regular course, and in its form nearly approaches a parabola.

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<sup>1</sup> *Zeitschrift f. Biologie von Pettenkofer und Voit*, Bd. xviii., p. 383.

TABLE VI.

HOLLAND'S INSTITUTE.

Hearing Distance for Whispered Speech of the Single Auditory Organs, Divided according to Approximately Equal Quotas.

Age.	15 and more. Met.	Below 15-8 Met.	8-4 Met.	4-2 Met.	2-1 Met.	100-50 Cm.	50-25 Cm.	25-12 Cm.	12-6 Cm.	6-3 Cm.	3 Cm. $\frac{1}{2}$	1 $\frac{1}{2}$ -0	Total of Auditory Organs Examined
10 years	9	7			1		1						18
11 "	8	13	2	3									26
12 "	16	14	5	2	1								38
13 "	14	6		1									22
14 "	16	8	1			2			1				30
15 "	24	9	1		2	1			1				38
16 "	21	3											24
17 "	9	3											12
18 "	8	4	2										14
Total	125	67	14	6	4	3	1		2				222

Quite similar, too, are the curves of each of the three schools separately, appearing on plate 4. The deviations of their forms are caused to a great extent only by the very variable number of those examined in the several schools. The course of the curves in general, however, is very uniform, and in not one of them do we see similar elevations such as we have met in Curves II. and I.

In dividing the hearing distances according to approximately equal quotas in the way I have selected, it appears, both from the regularity in the course of the curve comprising the total number of the pupils, and from the resemblance—to each other as well as to the total curve—of the graphic representations obtained from the several schools, that a general uniformity in the distribution of the various grades of capacity of the ear exists in the whole of a population of an equal age, which has astonished me. From the uniformity of our results in the several schools, and from the regular course of the curves gained from them, we are also justified in drawing the reciprocal conclusion that the present hearing examinations are reliable, and that whispered speech may be looked upon as an accoumeter sufficiently answering our expectations.

From these considerations it follows as a practical rule

TABLE VII.

COMMON SCHOOL II. A.

Hearing Distance for Whispered Speech of the Single Auditory Organs, Divided according to Approximately Equal Quotas.

Average Age.	Class in School.	18 and more —16 Metre.	16-8 Metre.	8-4 Metre.	4-2 Metre.	2-1 Metre.	100-50 Cm.	50-25 Cm.	25-12 Cm.	12-6 Cm.	6-3 Cm.	3 Cm. $\frac{1}{\infty}$	1 $\frac{1}{\infty}$	Total of Auditory Organs Examined.
7 yrs.	Boys' class Ia, b, & c	126	75	25	8	11	4	6	1				1	256
"	Girls' " Ia, b, & c	136	75	23	14	7	4	1	1					262
8 "	Boys' " IIa & b	142	57	21	4	2	4				2			232
"	Girls' " IIa, b, & c	128	105	49	15	3	4	1	2		1		1	308
9 "	Boys' " IIIa & b	117	57	28	5	6		1			2			218
"	Girls' " IIIa & b	54	62	32	14		4	2						168
10 "	Boys' " IVa & b	131	65	21	6	4	1	2		1				232
"	Girls' " IVa & b	82	82	23	10	4	4	1	1	3			2	212
11 "	Boys' " V . . .	40	45	20	6	1		1			1			114
"	Girls' " V . . .	82	59	31	10	4		2	2					192
12 "	Boys' " VIa & b	38	19	9	1			1						68
"	Girls' " VIa & b	38	17	11	4									70
13 "	Boys' " VII . . .	38												
"	Girls' " VII . . .													
	Total . . .	1,114	718	293	97	42	25	18	7	6	7	1	4	2,332

TABLE VIII.

## PROTESTANT SCHOOL II.

Hearing Distance for Whispered Speech of the Single Auditory Organs, Divided according to Approximately Equal Quotas.

Average Age.	Class in School.	20 and more — 16 Meter.	16-8 Meter.	8-4 Meter.	4-2 Meter.	2-1 Meter.	100-50 Cm.	50-25 Cm.	25-12 Cm.	12-6 Cm.	6-3 Cm.	3 Cm.	1 — 0 — 1 — ∞	Total of Auditory Organs Examined.
7 yrs.	Boys' class I . . . .	41	38	22	6	1		1		1				110
	Girls' " . . . .	65	49	18	4	2								138
8 "	Boys' " . . . .	36	52	22	7	3	2	3	1	1		1		128
	Girls' " . . . .	55	39	10	1	1								106
9 "	Boys' " . . . .	67	49	10	1	1	1		1					130
	Girls' " . . . .	45	35	16	1	1	1	1			1			100
10 "	Boys' " . . . .	52	53	20	6	2	5							138
	Girls' " . . . .	40	34	23	6	1								104
11 "	Boys' " . . . .	38	26	12	5	1		1					I (loud speech 5 Cm.)	84
	Girls' class V . . . .	27	23	3	4	3								60
12 "	Boys' " . . . .	20	18	9	1	1		1	1					50
	Girls' " . . . .	33	27	6	3	1	1	1			2			74
13 "	Girls' " . . . .	26	28	6										60
Total . . . .		545	471	177	44	17	10	8	3	2	3	1	1	1,282

for our tests of the hearing, that a special stress should be laid on an accurate determination of the small hearing distances of persons with impaired hearing, and that a difference of one centimetre in the hearing distance close to the ear implies much more than a difference of one metre or more at the limit of the normal hearing distance.

The total results of this review of the hearing distance of the several auditory organs is the following :

If we consider as pathological only those auditory organs which hear at 8 metres or less—that is, one-third of the normal distance and below, and count among the normal all those hearing beyond one-third, we get, as the result of the 3,836 auditory organs examined, 79.25 *per cent. normal* and 20.75 *per cent. pathological*.

The following tables give an insight into the apportionment of impaired hearing among the *individuals*. In Tables IX., X., and XI. is given in the first place the hearing distance of the several individuals, divided with reference to unilateral and bilateral affection, in each of the three schools examined.

Leaving out of consideration Holland's Institute, where there were only 18 per cent. hearing at less than one-third—a fact easily explained, as persons with greatly impaired hearing rarely resolve to attend the higher grades of schools,—the result yielded from the two public schools is pretty uniform.

In the common school there were found among 1,166 pupils 73.5 per cent. with perfectly or approximately normal hearing, and 26.5 per cent. hearing on one or both sides at less than one-third; in the Protestant school, 74.1 per cent. with entirely or nearly normal hearing, and 25.9 per cent. hearing on one or both sides at less than one-third.

If we tabulate the individuals of *all* of the three schools according to their average ages, as has been done in table XII. (p. 183), we obtain 74.2 per cent. with normal hearing, and 35.8 ear patients; of these, 6.7 per cent. hear on *both sides* at less than 8 metres, and 5 per cent. on *both sides* at less than 4 metres.



TABLE IX.

## HOLLAND'S INSTITUTE.

Hearing Distance for Whispered Speech of the Individuals, Divided with Reference to Unilateral and Bilateral Affection.

Class.	Beyond 15 metres on both sides.	15-8 Metres		Total persons hearing above 8 metres on both sides.	8-4 Metres		4-0 Metres		Total persons hearing on one and both sides below 8 metres.	Number of pupils examined.
		on one side (other side above 16 metres).	on both sides.		on one side (other side above 8 metres).	on both sides.	on one side (other side above 4 metres).	on both sides.		
Latin class I										
Average 10 years	4	1	3	8				1	1	9
Latin class II										
Average 11 years	4	2	4	10	1		1	1	3	13
Latin class III										
Average 12 years	7	2	5	14	3		1	1	5	19
Latin class IV										
Average 13 years	6	1	2	9	1		1		2	11
Latin class V										
Average 14 years	7	1	3	11	1	1	1	1	4	15
College class I										
Average 15 years	11	1	4	16	1			2	3	19
College class II										
Average 16 years	9	3		12						12
College class III										
Average 17 years	4	2		6						6
Upper class										
Average 18 years	4		1	5	2				2	7
Total . . .	56	13	22	91	9	1	4	6	20	111
Percentages .	50.5	11.7	19.8	82.0	8.1	0.9	3.6	5.4	18.0	100

If we compare the relative frequency of persons with impaired hearing in *the different ages of life*, the percentages of those having less than one-third of the normal acuteness of hearing in the first four years of school life, from the sixth to the tenth, show but slight variations, between 25 and 26.1 per cent. Greater variations, between 19.1 and 31 per cent., were found in the years from 11 to 13. But here the total numbers of those examined are much smaller, and the figures obtained, therefore, less demonstrative; if we summarize these three years, we again obtain an average value approximating to the one above, viz., 26.5 per cent. At the age from 14 to 18 years, the number examined was too small to justify us in drawing any conclusions.

TABLE X.  
COMMON SCHOOL II. A.

Hearing Distance for Whispered Speech, Divided with Reference to Unilateral and Bilateral Affection.

Average age.	Class.	16-8 Metres		8-4 Metres		4-0 Metres		Total persons hearing on one and both sides below 8 met.	Number of pupils examined.
		Above 16 metres on both sides.	on one side (other side above 16 met.).	on one side (other side above 8 metres).	on both sides.	on one side (other side above 4 metres).	on both sides.		
7 years	Boys' class Ia, b, and c	53	18	10	5	8	11	34	128
	Girls' " Ia, b, and c	52	23	6	7	11	9	33	131
8 "	Boys' " IIa and b	61	18	7	5	6	3	21	116
	Girls' " IIa, b, and c	53	19	12	13	16	5	46	154
9 "	Boys' " IIIa and b	50	15	10	7	6	5	28	109
	Girls' " IIIa and b	21	11	9	6	12	4	31	84
10 "	Boys' " IVa and b	57	15	7	5	5	5	22	116
	Girls' " IVa and b	32	18	7	5	7	9	28	106
11 "	Boys' " V	12	15	10	5	3	3	21	57
12 "	Girls' " VIa and b	34	13	6	11	6	7	30	96
	Boys' " VII	15	8	1	3	2	2	6	34
13 "	Girls' " VII	15	8	2	3	4		9	35
Total		455	181	87	75	86	61	309	1,166
Percentages of the totals.		39.1	15.5	7.5	6.4	7.4	5.2	26.5	100

TABLE XI.

## PROTESTANT SCHOOL II.

Hearing Distance for Whispered Speech, Divided with Reference to Unilateral and Bilateral Affection.

Average age.	Class.	Above 16 met. on both sides.		16-8 Metres on one side (other side above 16 met.).		8-4 Metres on one side (other side above 8 metres).		4-0 Metres on one side (other side above 4 metres).		Total persons hearing on one and both sides below 8 met.	Number of pupils examined.
		16 met.	8 met.	16 met.	8 met.	8 met.	4 met.	4 met.	0 met.		
7 years	Boys' class I	17	13	7	5	37	7	3	3	18	55
	Girls' " Ia and b	27	19	8	5	54	8	4	1	15	69
8 "	Boys' " II	14	17	7	11	38	11	4	7	20	64
	Girls' " III	22	13	11	2	46	4	4	1	7	53
9 "	Boys' " III	20	17	9	4	55	4	2	1	10	65
	Girls' " III	18	11	9	4	38	4	3	2	12	50
10 "	Boys' " IV	21	18	10	6	49	6	7	3	20	69
	Girls' " IV	17	12	6	2	35	4	5	1	17	52
11 "	Boys' " V	15	8	6	3	29	4	4	2	13	42
	Girls' " V	13	9	1	3	23	3	1	3	7	30
12 "	Boys' " VI	8	4	4	5	16	2	1	1	9	25
	Girls' " VI	15	11	3	2	29	2	2	4	8	37
13 "	Girls' " VII	10	10	6	2	26	2	2	4	4	30
Total		226	162	87	54	475	52	31	29	166	641
Percentages of the totals		35.3	25.3	13.6	8.4	74.1	8.1	4.8	4.5	25.9	100

TABLE XII.  
Prevalence of Unilateral and Bilateral Impaired Hearing among the Different Ages.

Age.	16-8 Metres		8-4 Metres		4-0 Metres		Total persons hearing on both sides above 8 met.	Total persons hearing on one and both sides below 8 met. in percentages.	
	Above 16 met. on both sides.	on one side above 16 met. (other side above 16 met.)	on one side above 8 met. (other side above 8 met.)	on both sides.	on one side above 4 met. (other side above 4 met.)	on both sides.			
7 years	149	56	283	78	26	24	26	100	383
8 "	150	55	287	82	32	26	26	100	387
9 "	118	44	227	65	27	22	20	81	308
10 "	131	50	264	83	22	23	24	88	352
11 "	44	24	98	30	17	9	9	44	142
12 "	64	22	125	39	16	15	8	52	177
13 "	46	23	89	20	6	8	7	21	110
14 "	7	1	11	3	1	1	1	4	15
15 "	11	1	16	4	1	2		3	19
16 "	9	3	12						12
17 "	4	2	6						6
18 "	4		5	1	2			2	7
Total	737	281	1,423	405	150	128	121	495	1,918
Percentages of the totals	3.85	14.6	74.2	21.1	7.8	6.7	6.3	25.8	100

TABLE XIII.  
Prevalence of Unilateral and Bilateral Impaired Hearing, according to Sex.

	Above 16 Metres on both sides.	16-8 Metres		Total persons hearing on both sides above 8 Metres.	8-4 Metres		4-0 Metres		Total persons hearing on both sides above 8 Metres.	Number of pupils examined.
		on one side (other side above 16 Metres).	on both sides.		on one side (other side above 8 Metres).	on both sides.	on one side (other side above 4 Metres).	on both sides.		
Boys . . . . .	236	74	82	392	35	25	27	24	111	503
Girls . . . . .	104	43	77	224	34	24	21	17	96	320
Common School II. A . . . . .	56	13	22	91	9	1	4	6	20	111
Holland's Institute . . . . .	219	107	139	465	52	50	59	37	198	663
Common School II. . . . .	122	44	85	251	28	28	10	12	70	321
Total boys . . . . .	396	130	181	707	78	50	52	47	227	934
" girls . . . . .	341	151	224	716	72	78	69	49	268	984
Total boys in percentages . . . . .	42.4	13.9	19.4	75.7	8.4	5.4	5.6	5.0	24.3	100
" girls " . . . . .	34.9	15.3	22.8	72.8	7.3	7.9	7.0	5.0	27.2	100

From the results of his investigations, Weil has drawn the conclusion that even in the school years disturbances of hearing rise in frequency with increasing age ; this author, to be sure, has examined a larger number of older pupils in the middle schools than were at my disposal. The numbers I have given above do not testify in favor of a material increase of impaired hearing even in the school age, and I must confess that from the start I did not expect any confirmation in this direction, bearing in mind the analogous conditions in the eye. For, in the latter, too, a gradual decline in the functional capacity can be demonstrated with increasing age, and Donders <sup>1</sup> caused his pupil de Haan to make investigations in this direction on a larger number of normal eyes. Their results, however, showed a clearly marked decline of the visual acuteness from the thirtieth year of life. We could expect to find similar conditions also in tests of the hearing power. That the increase of impaired hearing in old age is quite enormous I have convinced myself by testing the acuteness of hearing in a home for the aged, about which I shall report in a subsequent paper.

Finally, in Table XIII. is given a synopsis of unilateral and bilateral impairment of hearing according to the sexes. There are among the boys, 75.7 per cent. normal, and 24.3 per cent. hearing at less than one-third ; girls, 72.8 per cent. normal, and 27.2 per cent. hearing at less than one-third.

This small difference between boys and girls in favor of the former is sufficiently explained by the comparatively better results among the Latin scholars and college boys of the Holland Institute, for which the reason has been given above.

If we compare the percentages of defective hearing found in the several schools, and at the different ages examined, and in the two sexes, we find a coincidence which must appear remarkable enough.

*As the total average we obtain 25.8 per cent., or nearly 26 per cent., possessing only one-third or less of the normal hear-*

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<sup>1</sup> "Anomalien der Refraction und Accommodation," 1866, p. 161.

*ing distance. 14.5 per cent. of the whole—of which 7.8 per cent. unilaterally and 6.7 per cent bilaterally—perceive whispered speech, heard by the normal ear at 20–25 metres, only at 8–4 metres; and 11.3 per cent of the whole—of which 6.3 per cent. unilaterally and 5.0 per cent. bilaterally—hear the whisper only between 4–0 metres.*

Aside from ascertaining the hearing distance of a larger number of auditory organs and its distribution among individuals, the main task I had set myself in my investigations in schools was directed to the etiology of diseases of the ear, so far as it could be reached by way of statistics, and to the occurrence of the several subjective and objective phenomena which are regarded as symptoms of disease, as affecting on the one hand persons with normal, and on the other hand those with defective hearing of various degrees.

It would have taken too long a time to arrive at the history by verbal inquiry, and besides, at least in the youngest children, would have been effected but very imperfectly. Therefore, the children were given each a question blank, to be filled by their parents or relatives before coming under examination. The teachers had agreed to specially request the parents through the children to answer the questions carefully, even in cases where there was no disease of the ear. The questions comprised: (1) Former or present purulent discharge; (2) Previous diseases of children; (3) Possible connection of the otorrhœa with the latter; (4) The presence of any hereditary tendency. I append the contents of the blank:

*Blank for Ascertaining Former or Present Affections of the Ear.*

Given Name.	Surname.	Date of Birth.	Class in School.

1. Has a discharge from one or both ears been observed formerly, and at what age?

2. Up to what age did the discharge remain? Was it periodical or continuous? Offensive or not?

3. What diseases have been present? The most important in this inquiry are: scarlet-fever, measles, rubeolæ, other eruptions of the skin, diphtheria, cerebro-spinal meningitis.

4. Did the discharge from the ear first occur during one of these diseases, and how long after the appearance of the eruption or after the beginning of the disease?

5. Brief mention of other diseases (formerly or still present) of the right or left or both ears; pains, ringing, occasional defective hearing?

6. Is either of the parents, of the paternal or maternal grandparents, of the brothers, sisters, uncles, aunts, or their children deaf? On one or both sides? With or without discharge from the ear? Deaf from birth or become so at what age?

The blanks had been filled up pretty completely so far as this could be expected with the varying grade of education of the relatives. The different orders of society were represented in the two public schools about in proportion to the total population. In examining the blanks I have convinced myself how slight the demands must be which we make of the average population in such statistical investigations. Thus, for instance, it frequently happened that under question 3 a number of diseases were enumerated and the answer to question 4 read briefly: "After the disease," etc. Therefore it was not possible to arrive at any certain conclusion directly from the blanks as to how often present or past otorrhœas should be attributed to one or other of the acute infectious diseases. In harmony with the universal experience of otologist, scarlatina was most frequently named as the starting-point of suppuration of the ear. The next most frequent primary disease was measles. Once only is the beginning of the discharge reported during true diphtheria, once with rubeolæ, and once with "chicken-pox." In the latter case, three brothers and sisters were suffering at the same time from bilateral discharge; whether all of them in consequence of varicella is not stated. A special dislike is manifested in a small part of the population against vaccination, to which otorrhœa was repeatedly attributed. One father even states that



ever since then there had appeared, besides the discharge, some eruptions and a sore on the arm which still remained. If we take into consideration the acute inflammatory alterations of all grades which are exceedingly frequent, and which Wendt found in the middle ear in his numerous autopsies of small-pox patients, we can justly assert that vaccination offers protection rather than danger for the ear likewise.

In tabulating the different acute infectious diseases, I had to proceed in part somewhat arbitrarily. Thus I have enumerated the terms "Fleckeln, red spots, Frieseln" among measles, croup under diphtheria. Where scarlatina, diphtheria, and possibly some other diseases are reported, it is generally impossible from the statements to ascertain whether the diphtheria appeared only as a concomitant of the scarlatina or at another time; therefore in these cases both had to be entered separately. Despite the various sources of error above mentioned, I do not hold the results of these investigations regarding the acute infectious diseases and the statistics of morbidity in general to be worthless, especially as it is difficult in one of the larger cities to gain, in some other way than the one here followed, a complete insight into a larger number of persons of like age. We shall see below to what extent the total figures here obtained point to a dependence of the ear disease upon the general affections taken into consideration.

The children provided with their filled-in blanks were tested first for their hearing distance of whispered speech, and on one of the succeeding days examined with the otoscope; the otoscopical examination included all the children, both those with normal and those with defective hearing; in Holland's Institute this was done by artificial light, in the two public schools by daylight. Where perforation of the drumhead could not be perceived directly, but appeared probable from the other findings, I have employed auscultation during the performance of Politzer's procedure in order to settle the question.

The results of the examination of each person were entered into the following blank (here reduced):

SCHOOL.					CLASS.		PLACE OF EXAMINATION.						
No.	Given name.	Surname.	Age.	Side.	Hearing distance for low speech.	Cerumen.		Drumhead.					Remarks.
						Not plugging.	Plugging.	Reflexes.	Color and calcification.	Anomalies of form.	Perforation.	Otorrhea.	
1			R	L									
2			R	L									

The normal relation, as well as all the several deviations from it which showed themselves on the drumhead, were carefully noted and entered into the three columns, "Reflexes, Color and calcification, and Anomalies of form." The intention I had in view was to ascertain statistically how frequent are the several deviations on the drumhead which we know, for instance, as characteristic of depression, etc., together with real disturbances of hearing still present; I intended to test all the anomalies of the drumhead in their order as bearing on our diagnosis. The work was rather laborious and slow, but I know no other way by which it would be possible to obtain positive knowledge as to which alterations on the drumhead are of actual pathological importance, and which still belong to the normal condition, unless it be the examination of a larger number of individuals out of the total population.

I have laid special stress on a careful tabulation of all the drumhead reflexes present, both regular and irregular, so as to get a clear conception at last to what extent the altered curvatures of the drumhead, of which they are the expression, have to be weighed in reference to the function of the ear and to our diagnosis.

If we familiarize ourselves with the origin of the drumhead reflexes and their manifold changes under pathological conditions, otoscopy ranges itself by the side of the best medical methods of examination in our possession, by giving us information of a number of relatively very slight alterations of form, which often can be recognized by this means alone,

and which are able to furnish important landmarks for our diagnosis.

Helmholtz was the first to point out, and Politzer has proved by experiment, that the normal triangular reflex can be produced only at the point where the drumhead meets our visual axis vertically.

Whenever we extend this axiom to all the other, both normal and pathological, reflexes of the drumhead, they will become clear to us in their mode of origin, and permit us to draw positive deductions as to the special changes of form underlying their source. I have, on a previous occasion,<sup>1</sup> given the explanation of the formation of a number of reflexes in connection with a schematic section of the auditory canal and drumhead. Inasmuch as the drawing in the *Berliner klinische Wochenschrift* did not exactly come up to

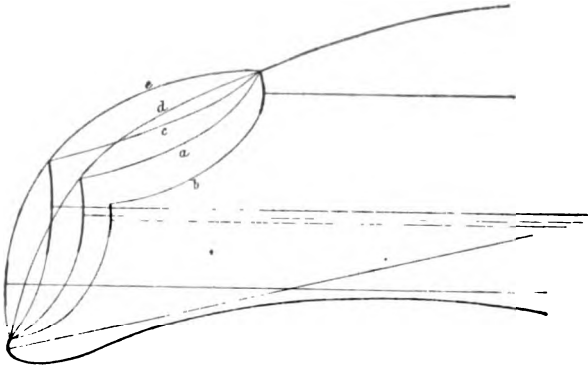


Fig. 1.

my expectations, I subjoin it again here in Fig. 1. In Fig. 2 are marked all the reflexes on the drumhead which occur under normal conditions of curvature.

The section (Fig. 1) passes through the axis of the auditory canal in such a way as to cut the triangular reflex of the drumhead lengthwise into halves—that is to say, divide the drumhead as indicated in Fig. 2. So far as this sectional line runs through the normal reflex, it is met vertically by our visual axis. The fact that the direction of the

<sup>1</sup> "Die Verschlussung der Tuba Eustachii, ihre physikalische Diagnose und Einwirkung auf die Function des Ohres." Vortrag, gehalten im ärztlichen Bezirksverein zu München.—*Berliner klin. Wochenschr.*, 1883, No. 36.

reflex runs downward and forward is due to the double inclination of the drumhead; its triangular form depends on the obtuse-angled funnel-shape of the membrane, as Trautmann has shown. In order to get an idea of the origin of the triangular form, we may imagine that from the periphery of the reflex to the umbo a series of infinitely small transverse sections of hollow cylinders follow each other, every succeeding one of which corresponds to a cylinder having a smaller basal radius.

The section through the *normal* drumhead (Fig. 1, *a*) shows at once why the triangular reflex has exactly the

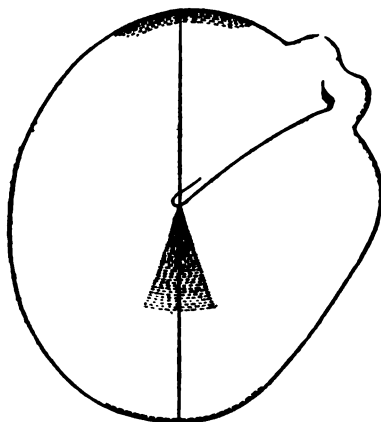


Fig. 2.

length found on the average under normal conditions and cannot reach the periphery.

The drumhead section *b*, in which the membrane is drawn bulged out by condensation of the air in the cavities of the middle ear, shows how, on the one hand, the triangular reflex shortens in this position; on the other, a second reflex of convexity appears on the posterior upper periphery, where now likewise a part comes to lie vertically to our visual axis.

Sections *c*, *d*, and *e* show different grades of depression of the drumhead, by reason of rarefaction of the air in the middle ear.

In section *c* the convexity of the surface of the funnel is

diminished, but the funnel shape is still preserved; the triangular reflex, therefore, has become longer, and narrower on its base.

In section *d* the surface of the funnel, by preponderance of the external atmospherical pressure, has become outwardly concave just as much as it is externally convex on the normal drumhead; the place of the umbo, which was moved inwards during the simple straightening of the radial fibres drawn in section *c*, has now returned to its normal place, and the funnel shape of the drum has changed into that of a shallow pan. In this section no part of the drumhead met by our visual axis is vertical to it, hence every reflex is absent.

Finally, in section *e*, owing to a stretching of the radial fibres, the concavity of the entire drumhead outwardly has still more increased, and now a reflex again occurs—that is, a true concave speculum reflex, which, however, no longer begins in the umbo, but has moved far away from the umbo toward the periphery, forward and downward. This reflex, of course, can no longer possess a triangular form, because the funnel shape of the drum has been lost, but represents a roundish, square, or irregular spot, often having a remarkably bright lustre. Magnus<sup>1</sup> already noticed this roundish reflex displaced toward the periphery, in his studies on the behavior of the organ of hearing in compressed air, but interpreted it as the consequence of a greater local depression merely.

Another *linear* glossy streak is found almost exclusively along the anterior lower periphery of the drumhead, provided the structure of the auditory canal permits of its being seen. This reflex arises, as I have convinced myself, no longer exclusively in the drumhead itself, but lies in the groove between the limbus of the drum and the external lip of the sulcus. This glossy streak, which I have termed “sulcus reflex,” as well as the above-mentioned reflex of convexity, which arises at the posterior upper periphery during bulging of the drumhead, are cut *in half* under regular conditions by our line of section, the same as the

<sup>1</sup> *Arch. f. Ohrenheilk.*, Bd. i., p. 273.

triangular reflex. I shall explain below why I have directed particular attention to this reflex streak, and entered it in all cases in my investigations in schools.

Two small reflexes remain to be mentioned, which may be present under normal conditions. The one is at the point of the short process when its cartilaginous investment is more strongly developed so as to form a roundish knob. The other is produced in a similar manner as the sulcus reflex at the anterior upper margin of the membrana Shrapnelli.

*All the other reflexes occurring on the drumhead are of a pathological nature, and owe their origin to alterations of form of the membrane.*

A number of them occur in the nearest surroundings of the short process as the expression of its greater prominence. Thus must be interpreted as pathological the normally small linear reflex of the membrana Shrapnelli whenever it becomes spot-like, also the glossy point on the short process whenever it extends as a line, no matter how short, on the so-called posterior fold. Above this fold too, one or several reflexes may occur; or else the entire approximately triangular surface lying above it, as far as the periphery, may shine uniformly when it represents either a level plane or a concavity which is met vertically by our visual axis.

By far the majority of the pathological reflexes present at unusual places of the drumhead are reflexes of concavity, and characterize local depressions and, when the borders of the depression are more sharply circumscribed, cicatrices, or, when spread over a larger portion of the drumhead, atrophy and collapse of the latter. They give us a very distinct picture of the alterations of form present, especially in conjunction with the reflexes of convexity occurring after the air douche on corresponding or neighboring places.

It may be learned from the résumé here given, which contains in brief my experience gained in an extensive clinical observation respecting the occurrence of drumhead reflexes, that their origin can be explained throughout in a simple manner, from the same point of view.

It was indispensable for the purpose of this paper to enter more fully here into the formation of the normal and

pathological drumhead reflexes ; for the statistical results to be reported in the following pages are to be considered, as it were, as a test of the correctness of the clinical experience regarding their pathological importance and their diagnostic value.

In order to gain a serviceable view of the large mass of single observations which I had jotted down into the above blanks, the several phenomena found on the drumhead were entered in their order of frequency in the following tables XIV.-XIX., and grouped in them with reference to the hearing distance present at the same time. The hearing distances found were brought into four larger divisions, the last of which comprises those auditory organs which hear whispered speech between 0-4 metres, and every next preceding column the organs with double the hearing distance of that immediately below—that is, with 4-8, 8-16, 16 and more metres.

Besides the normal and pathological appearances of the the drumhead, the occurrence of otorrhœa and of occluding and non-occluding accumulations of cerumen was likewise noted in these tables with reference to the hearing distance present at the time. Finally, in the same tables were recorded all the data reported as to former ear affections, general diseases, trauma, and hereditary taint. I should have preferred to extend my investigations to the cranio-tympanic conduction, the perception of the higher tones, Rinne's experiment, etc.; but neither the time granted me for the examination by the authorities nor my own would have sufficed for these time-consuming methods; these, which certainly could give many new statistical landmarks as to the value of these various modes of examination, I must leave for some future investigator, who will also find the way better prepared for him when the interest in hearing tests of school-children will have become more general.

I subjoin here the tabular statement of the several pathological alterations and the items of historical interest. Tables XIV.-XVI. (pp. 196-201) give the particulars of each of the schools examined; tables XVII. and XVIII.

(pp. 202-205), of the number of boys and girls in the two public schools; table XIX. (p. 206), of the total number of children in the two public schools.

The several numbers of the four columns in each table, which contain the four different quotas of hearing, can, then, only be compared with each other, when we refer every number found to an equal number of persons examined. For this reason in the *right* half of every table the several numbers are calculated for one hundred persons examined in every single column—that is, stated in percentages of the single column. In the same way the total number of persons examined, which is contained in the last column, is expressed in percentages.

In Holland's Institute the number of Latin scholars and college boys examined was too small to render the division of the hearing distance into four columns feasible. Therefore only two columns were made, containing respectively the auditory organs perceiving *below* eight metres, and those *above* eight metres. For this reason I was unable to utilize further in tables XVII.-XIX. the data of table XVI., which contains the prevalence of pathological alterations and the items of history in Holland's Institute.

In this school, too, some consideration was given to the *pharyngeal space* in all the persons examined, so far as simple inspection from the mouth will permit it. The results of the examination noted in the table do not allow us to recognize any preponderance of impaired hearing in connection with pharyngeal affections visible from the mouth.

I found :

Hearing Distance.	Absolute numbers.			Percentages.		
	Above 8 Met.	Below 8 Met.	Total.	Above 8 Met.	Below 8 Met.	Total.
Total number examined . . .	192	30	222	100	100	100
Hypertrophied tonsils . . .	33	5	38	17.2	16.7	17.1
Pharyngitis diffusa . . .	38	6	44	19.8	20.0	19.8
Pharyngitis granulosa . . .	12		12	6.3		5.4
Lateral tumors . . .	27	3	30	14.1	10.0	13.5
Nasal speech . . .	1	5	6	0.5	16.7	2.7



TABLE XIV.  
COMMON SCHOOL II. A.  
Boys and Girls.

Hearing distance for whispered speech.	Number of auditory organs.				Total.	In percentages of each column.				Total.
	Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.	
Total auditory organs perceiving at the above distances in the schools	1114	718	293	207	2332	100	100	100	100	100
<i>a</i> Hindering examination . . . . .	79	60	18	10	167	7.1	8.4	6.1	4.8	7.2
<i>b</i> Apparently occluding . . . . .	8	17	7	14	46	0.7	2.4	2.4	6.8	2.0
Normal drumhead	968	584	196	83	1831	86.9	81.3	66.9	40.1	78.5
Sulcus reflex covered by the anterior lower wall of the ear canal . . . . .	402	251	106	49	808	36.1	35.0	36.2	23.7	34.6
Normal reflex absent . . . . .	20	37	20	21	98	1.8	5.2	6.8	10.1	4.2
Pathological state of the drumhead	22	26	34	36	118	2.0	3.6	11.6	17.4	5.1
Macular reflex <i>above</i> the short process . . . . .	8	8	4	3	23	0.7	1.1	1.4	1.4	1.0
Punctiform linear or more expanded reflex <i>behind</i> the short process . . . . .	18	26	17	12	73	1.6	3.6	5.8	5.8	3.1
Diffuse reddening or extravasation of blood . . . . .	2	2	1	2	7	0.2	0.3	0.3	1.0	0.3
Serum perceptible in the drum cavity . . . . .		1	2	3	6		0.1	0.7	1.4	0.3
Color anomalies of the drumhead	15	14	14	12	55	1.3	2.0	4.8	5.8	2.4
Circumscribed opacities . . . . .	114	104	49	20	287	10.2	14.5	16.7	9.7	12.4
Calcifications . . . . .	14	6	8	7	35	1.3	0.8	2.7	3.4	1.5
Posterior streak of opacity . . . . .	56	42	21	11	130	5.0	5.9	7.2	5.3	5.6
Posterior fold . . . . .	50	58	48	50	206	4.5	8.1	16.4	24.2	8.8
Form anomalies of the drumhead	9	17	12	7	45	0.8	2.4	4.1	3.4	1.9
Manubrium mallei widened or short process projecting . . . . .	7	8	8	5	28	0.6	1.1	2.7	2.4	1.2
Atrophy . . . . .	10	16	14	10	50	0.9	2.2	4.8	4.8	2.2
Cicatrix . . . . .										

TABLE XIV.—*Continued.*

COMMON SCHOOL II. A.

Boys and Girls.

Hearing distance for whispered speech.	Number of auditory organs.				Total.	In percentages of each column.				Total.	
	Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		
Perforation of the drumhead {	With otorrhœa . . . . .	.	.	.	.	.	.	.	.	.	1.2
	Without otorrhœa . . . . .	.	.	.	.	.	.	.	.	.	1.2
	Nasal speech . . . . .	.	.	.	.	.	.	.	.	.	1.2
	Former discharge . . . . .	.	.	.	.	.	.	.	.	.	9.7
	Former impaired hearing . . . . .	.	.	.	.	.	.	.	.	.	5.7
Former ear affections {	Former tinnitus . . . . .	20	33	24	55	132	1.8	4.6	8.2	26.6	5.7
	Former earache . . . . .	24	19	17	12	72	2.2	2.6	5.8	5.8	3.1
	Scarlatina . . . . .	48	59	26	24	157	4.3	8.2	8.9	11.6	6.7
	Morbilli . . . . .	240	159	67	58	524	21.5	20.2	22.9	28.0	22.5
	Rubeola . . . . .	555	375	165	105	1200	49.8	49.7	56.3	50.7	51.5
Other history {	Diphtheria . . . . .	254	177	56	39	526	22.8	24.7	19.1	18.8	22.6
	Meningitis . . . . .	235	166	65	62	528	21.0	23.1	22.2	30.0	22.6
	Trauma . . . . .	23	17	5	3	48	2.1	2.4	1.7	1.4	2.1
	Heredity . . . . .	100	62	27	31	220	9.0	8.6	9.2	15.0	9.4
	Not examined with speculum on account of disease, etc. . . . .	24	20	10	4	56					

TABLE XV.  
PROTESTANT SCHOOL II.  
Boys and Girls.

Hearing distance for whispered speech.		Number of auditory organs.				In percentages of each column.					
		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.	Total.	Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.	Total.
Total auditory organs perceiving at the above distances in the school.											
Cerumen	a. Hindering examination . . . . .	545	471	177	89	1282	100	100	100	100	100
	b. Apparently occluding . . . . .	73	67	15	13	168	13.4	14.2	8.5	14.6	13.1
Normal drumhead reflexes	Triangular spot or point in or near the umbo . . . . .	9	12	9	18	48	1.7	2.5	5.1	20.2	3.8
	Sulcus reflex covered by the anterior lower wall of the ear canal. . . . .	466	360	128	30	984	85.5	76.4	72.3	33.7	76.8
Pathological state of the drumhead reflexes	Normal reflex absent . . . . .	135	114	39	11	299	24.8	24.2	22.0	12.4	23.3
	Normal reflex far removed from the umbo toward the periphery . . . . .	15	20	8	6	49	2.8	4.2	4.5	6.7	3.8
	Macular reflex <i>above</i> the short process . . . . .	10	22	15	15	62	1.8	4.7	8.5	16.9	4.8
	Punctiform, linear, or more expanded reflex <i>behind</i> the short process . . . . .	3	4	1	2	10	0.6	0.8	0.6	2.2	0.8
Color anomalies of the drumhead	Diffuse reddening or extravasation of blood . . . . .	15	22	7	7	51	2.8	4.7	4.0	7.8	4.0
	Serum perceptible in the drum cavity . . . . .	2	2	2	2	8	0.4	0.4	1.1	2.2	0.6
	Diffuse opacity . . . . .	1	1	3	3	4	0.2	0.2	1.7	0.3	0.3
	Circumscribed opacities . . . . .	4	13	6	6	23	0.8	2.8	3.4	1.8	1.8
Form anomalies of the drumhead	Calcifications . . . . .	59	68	30	13	170	10.8	14.4	16.9	14.6	13.3
	Posterior streak of opacity . . . . .	8	6	3	3	20	1.5	1.3	1.7	3.4	1.6
	Posterior fold . . . . .	6	12	9	3	30	1.1	2.5	5.1	3.4	2.3
	Manubrium mallei widened, or short process projecting . . . . .	10	23	19	11	63	1.8	4.9	10.7	12.4	4.9
	Atrophy . . . . .	6	15	8	8	37	1.1	3.2	4.5	9.0	3.9
	Cicatrix . . . . .	4	9	4	4	21	0.8	1.9	2.3	4.5	1.6
		1	9	5	5	20	0.2	1.9	2.8	5.6	1.6

TABLE XV. — *Continued.*

PROTESTANT SCHOOL II.

Boys and Girls.

Hearing distance for whispered speech.	Number of auditory organs.				Total.	In percentages of each column.				Total.		
	Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.			
Perforation of the drumhead { Former ear affections {	With otorrhœa . . . . .	.	.	.	.	.	.	.	.	.	.	.
	Without otorrhœa . . . . .	.	.	.	.	.	.	.	.	.	.	.
	Nasal speech . . . . .	.	.	.	.	.	.	.	.	.	.	.
	Former discharge . . . . .	3	25	25	32	91	1.7	5.3	14.1	36.0	7.1	6.6
	" impaired hearing . . . . .	13	29	15	28	85	2.4	6.2	8.5	31.5	6.6	2.9
Other history {	" tinnitus . . . . .	11	12	7	7	37	2.0	2.5	4.0	7.8	2.9	7.5
	" earache . . . . .	26	37	12	21	96	4.8	7.9	6.8	23.6	7.5	26.1
	Scarlatina . . . . .	120	134	50	30	334	22.0	28.0	28.2	33.7	26.1	54.4
	Morbilli . . . . .	308	233	91	45	697	54.7	53.7	51.4	50.6	54.4	17.3
	Rubeola . . . . .	86	78	30	28	222	15.8	16.6	16.9	31.5	22.8	1.1
	Diphtheria . . . . .	131	110	31	20	292	24.0	23.4	17.5	22.5	12.3	
	Meningitis . . . . .	7	6	1		14	1.3	1.3	0.6			
	Trauma . . . . .											
	Hereditv . . . . .	66	49	29	14	158	12.1	10.4	16.4	15.7		
	Not examined with speculum on account of disease, etc. . . . .	21	27	9	3	60						

TABLE XVI.  
HOLLAND'S INSTITUTE.

Hearing distance for whispered speech.		Number of auditory organs.		Total.	In percentages of each column.		Total.
		Above 8 Metre.	Below 8 Metre.		Above 8 Metre.	Below 8 Metre.	
Total auditory organs perceiving at the distance stated		192	30	222	100	100	100
Cerumen . . . . .	{ a. Hindering examination	10	3	13	5.2	10.0	5.9
	{ b. Apparently occluding . . . . .	2	2	4	1.0	6.7	1.8
Normal drum-head reflexes.	{ Normal reflex present . . . . .	185	19	204	96.4	63.3	91.9
	{ Sulcus reflex covered by the anterior lower wall of the ear canal	140	17	157	72.9	56.7	70.7
Pathological state of the drum-head reflexes	{ Normal reflex absent . . . . .	3	3	3	1.0	10.0	1.4
	{ Normal reflex far removed from the umbo toward the periphery	1	6	7	0.5	20.0	2.2
	{ Macular reflex <i>above</i> the short process . . . . .	6	7	6	3.1	3.3	2.7
	{ Punctiform, linear, or more expanded reflex <i>behind</i> the short process	4	1	5	2.1	3.3	2.3
Color anomalies of the drum-head	{ Diffuse opacity . . . . .	1	1	2	0.5	3.3	0.9
	{ Circumscribed opacities . . . . .	8	5	13	4.2	16.7	5.9
	{ Calcifications . . . . .	29	3	32	15.1	10.0	14.5
	{ Posterior streak of opacity . . . . .	2	2	2	1.0	0.9	0.9
Form anomalies of the drum-head	{ Posterior fold . . . . .	8	3	11	4.2	10.0	5.0
	{ Manubrium mallei widened or short process projecting . . . . .	14	9	23	7.3	30.0	10.4
	{ Atrophy . . . . .	5	2	7	2.6	6.7	3.2
	{ Cicatrix . . . . .	2	1	3	1.0	3.3	0.5
Perforation of the drum-head	{ With otorrhœa . . . . .						
	{ Without otorrhœa . . . . .	1	1	1	3.3	3.3	0.5

TABLE XVI.—Continued.  
HOLLAND'S INSTITUTE.

Hearing distance for whispered speech.		Number of auditory organs.		Total.	In percentages of each column.		Total.
		Above 8 Metre.	Below 8 Metre.		Above 8 Metre.	Below 8 Metre.	
Pharyngeal affections	Hypertrophied tonsils	33	5	38	17.2	16.7	17.1
	Pharyngitis diffusa .	38	6	44	19.8	20.0	19.8
	Pharyngitis granulosa .	12		12	6.3		5.4
	Lateral tumors .	27	3	30	14.1	10.0	13.5
	Nasal speech .	1	5	6	0.5	16.7	2.7
Former ear affections	Former discharge .	7	6	13	3.6	20.0	5.9
	Former impaired hearing .	7	4	11	3.6	13.3	5.0
	Former tinnitus .	2	2	4	1.0	6.7	1.8
	Former earache .	1	1	2	0.5	3.3	0.9
	Scarlatina .	64	8	72	33.3	26.7	32.4
Other history	Morbili .	108	22	130	56.3	73.3	58.6
	Rubeola .	41	3	44	21.4	10.0	19.8
	Diphtheria .	53	5	58	27.6	16.7	26.1
	Meningitis .	5	1	6	2.6	3.3	2.7
	Trauma .	1	4	5	0.5	13.3	2.3
	Heredity .	38	10	48	48.8	33.3	21.6

TABLE XVII.  
TOTAL NUMBER OF BOYS FROM THE TWO PUBLIC SCHOOLS.

Hearing distance for whispered speech.	Number of auditory organs.				In percentages of each column.			
	Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.	Total.	Above 16 Metre.	16-8 Metre.	8-4 Metre.
Total auditory organs perceiving at the above distances in the two schools . . . . .	808	509	199	130	1646	100	100	100
{ <i>a</i> Hindering examination . . . . .	73	58	12	11	154	9.0	11.4	8.5
{ <i>b</i> Apparently occluding . . . . .	5	15	2	21	43	0.6	2.9	1.0
Normal drumhead . . . . .	699	388	133	48	1268	86.5	76.2	66.8
Sulcus reflex covered by the anterior lower wall of the ear canal . . . . .	237	134	55	17	443	28.1	26.3	27.6
Normal reflex absent . . . . .	27	33	18	14	92	3.3	6.5	9.0
Pathological state of the drumhead reflexes . . . . .	18	17	20	15	70	2.2	3.3	10.1
Normal reflex far removed from the umbo toward the periphery . . . . .	7	8	2	2	19	0.9	1.6	1.0
Macular reflex <i>above</i> the short process . . . . .								
Punctiform, linear, or more expanded reflex behind the short process, . . . . .	11	24	11	9	55	1.4	4.7	5.5
Diffuse reddening or extravasation of blood . . . . .	2	1	1	3	7	0.2	0.2	0.5
Serum perceptible in the drum cavity . . . . .			3	2	5			1.5
Diffuse opacity . . . . .	10	12	10	2	34	1.2	2.4	5.0
Circumscribed opacities . . . . .	80	65	30	15	190	9.9	12.8	15.1
Calcifications . . . . .	9	3	6	4	22	1.1	0.6	3.0
Posterior streak of opacity . . . . .	48	28	14	5	95	5.9	5.5	7.0
Posterior fold . . . . .	37	49	33	30	149	4.6	9.6	16.5
Manubrium mallei widened or short process projecting . . . . .	6	18	10	6	40	0.7	3.5	5.0
Atrophy . . . . .	2	6	6	3	17	0.2	1.2	3.0
Cicatrix . . . . .	7	9	7	4	27	0.9	1.8	3.5
Color anomalies of the drumhead . . . . .								
Form anomalies of the drumhead . . . . .								
Total . . . . .								

TABLE XVII.—*Continued.*  
TOTAL NUMBER OF BOYS FROM THE TWO PUBLIC SCHOOLS.

Hearing distance for whispered speech.	Number of auditory organs.				Total.	In percentages of each column.				Total.
	Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.	
Perforation of the drumhead {	With otorrhœa . . . . .	.	.	.	15	0.4	0.8	0.5	10.8	0.9
	Without otorrhœa . . . . .	3	4	6	7	20	0.1	0.8	3.0	5.4
	Nasal speech . . . . .	1	4	11	12	28	0.1	0.8	5.5	9.2
	Former discharge . . . . .	38	34	34	42	148	4.7	6.7	17.1	32.3
	Former impaired hearing . . . . .	19	34	16	31	100	2.4	6.7	8.0	23.8
Former ear affections {	Former tinnitus . . . . .	.	.	.	7	30	1.0	2.2	4.5	5.4
	Former earache . . . . .	8	6	9	7	30	1.0	2.2	4.5	5.4
	Scarlatina . . . . .	50	28	16	21	115	6.2	5.5	8.0	16.2
	Morbili . . . . .	166	126	43	37	372	20.5	24.8	21.6	28.5
	Morbili . . . . .	401	262	93	61	817	49.6	51.5	46.7	49.6
Other history {	Rubeola . . . . .	147	103	34	26	310	18.1	20.2	17.1	20.0
	Diphtheria . . . . .	167	119	31	41	358	20.7	23.4	15.6	31.5
	Meningitis . . . . .	24	14			38	3.0	2.8		2.3
	Trauma . . . . .			2		2			1.0	0.1
	Heredity . . . . .	83	58	25	19	185	10.3	11.4	12.6	14.6
Not examined with speculum on account of disease, etc. . . . .	23	30	13	6	72					11.2



TABLE XVIII.  
TOTAL NUMBER OF GIRLS FROM THE TWO PUBLIC SCHOOLS.

Hearing distance for whispered speech.		Number of auditory organs.				Total.	In percentages of each column.				Total.	
		Number of auditory organs.					In percentages of each column.					
		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		
Total auditory organs among the girls perceiving at the above distances												
Cerumen	a. Hindering examination . . . . .	851	680	271	166	1968	100	100	100	100	100	
	b. Apparently occluding . . . . .	79	69	21	12	181	9.3	10.1	7.7	7.2	9.2	
	Triangular reflex or point in or near the umbo . . . . .	12	14	14	11	51	1.4	2.1	5.2	6.6	2.6	
Normal drumhead reflexes	Sulcus reflex covered by the anterior lower wall of the ear canal. . . . .	735	556	191	65	1547	85.2	81.8	70.5	39.2	78.6	
	Normal reflex absent . . . . .	300	231	90	43	664	35.3	34.0	33.2	25.9	33.7	
	Normal reflex far removed from the umbo toward the periphery . . . . .	8	24	10	13	55	0.9	3.5	3.7	7.8	2.8	
Pathological state of the drumhead reflexes	Macular reflex <i>above</i> the short process . . . . .	14	31	29	36	110	1.6	4.6	10.7	21.1	5.6	
	Punctiform, linear, or more expanded reflex <i>behind</i> the short process . . . . .	4	4	3	3	14	0.5	0.6	1.1	1.8	0.7	
	Diffuse reddening or extravasation of blood . . . . .	22	24	13	10	69	2.6	3.5	4.8	6.0	3.5	
Color anomalies of the drumhead	Serum perceptible in the drum cavity . . . . .	2	3	2	1	8	0.2	0.4	0.7	0.6	0.4	
	Diffuse opacity . . . . .	1	1	2	1	5	0.1	0.2	0.7	0.6	0.3	
	Circumscribed opacities . . . . .	9	15	10	10	44	1.0	2.2	3.7	6.0	2.2	
Form anomalies of the drumhead	Calcifications . . . . .	93	107	49	18	267	10.9	15.7	18.1	10.8	13.6	
	Posterior streak of opacity . . . . .	13	9	5	6	33	1.5	1.3	1.8	3.6	1.7	
	Posterior fold . . . . .	14	26	16	9	65	1.6	3.8	5.9	5.4	3.3	
Form anomalies of the drumhead	Manubrium mallei widened or short process projecting . . . . .	23	32	34	31	120	2.7	4.7	12.5	18.7	6.1	
	Atrophy . . . . .	9	14	10	9	42	1.0	2.1	3.7	5.4	2.1	
	Cicatrix . . . . .	9	11	6	6	32	1.0	1.6	2.2	3.6	1.6	
		4	16	12	11	43	0.5	2.4	4.4	6.6	2.2	

**TABLE XVIII.—Continued.**  
**TOTAL NUMBER OF GIRLS FROM THE TWO PUBLIC SCHOOLS.**

Hearing distance for whispered speech.	Number of auditory organs.				Total.	In percentages of each column.				Total.	
	Above 16 Metre.	8-4 Metre.	4-0 Metre.			Above 16 Metre.	8-4 Metre.	4-0 Metre.			
Perforation of the drumhead { Former ear affections	With otorrhœa . . . . .	.	.	.	.	.	.	.	.	.	.
	Without otorrhœa . . . . .	.	.	.	.	.	.	.	.	.	.
	Nasal speech {	.	.	.	.	.	.	.	.	.	.
	Former discharge . . . . .	2	3	7	17	20	0.2	0.7	10.2	1.0	0.8
	Former impaired hearing {	2	4	6	14	15	0.4	1.1	4.2	0.8	1.3
Former ear affections	Former tinnitus . . . . .	26	49	41	54	170	0.2	2.2	8.4	1.3	8.6
	Former earache . . . . .	14	28	23	52	117	3.1	7.2	32.5	8.6	5.9
	Former earache . . . . .	27	25	15	12	79	1.6	4.1	8.5	31.3	7.0
	Scarlatina . . . . .	24	68	22	24	138	3.2	3.7	5.5	7.2	4.0
	Morbili . . . . .	194	167	74	51	486	2.8	10.0	8.1	14.5	7.0
Other history	Rubeola . . . . .	462	366	163	89	1080	22.8	24.6	27.3	30.7	24.7
	Diphtheria . . . . .	193	152	52	41	438	54.3	53.8	60.0	53.6	54.9
	Meningitis . . . . .	199	157	65	41	462	22.7	22.4	19.2	24.7	22.3
	Trauma . . . . .	6	9	6	3	24	23.4	23.1	24.0	24.7	23.5
	Heredity . . . . .	83	53	31	26	193	0.7	1.3	2.2	1.8	1.2
Not examined with speculum on account of disease, etc.	Not examined with speculum on account of disease, etc. . . . .	22	15	6	1	44	9.8	7.8	11.4	15.7	9.8

TABLE XIX.  
TOTAL NUMBER OF BOYS AND GIRLS FROM THE TWO PUBLIC SCHOOLS.

Hearing distance for whispered speech.		Number of auditory organs.				Total.	In percentages of each column.				Total.
		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.	
Total auditory organs in both schools perceiving at the above distances		1659	1189	470	296	3614	100	100	100	100	100
Cerumen.	a. Hindering examination . . . . .	152	127	33	23	335	9.16	10.68	7.02	7.77	9.27
	b. Apparently occluding . . . . .	17	29	16	32	94	1.02	2.44	3.40	10.81	2.61
Normal drumhead reflexes	Triangular spot or point in or near the umbo . . . . .	1437	944	324	113	2815	86.44	79.39	68.94	38.18	77.89
	Sulcus reflex covered by the anterior lower wall of the ear canal . . . . .	537	365	145	60	1107	32.37	30.70	30.85	20.27	30.63
Pathological state of the drumhead reflexes	Normal reflex absent . . . . .	35	57	28	27	147	2.11	4.79	5.96	9.12	4.07
	Normal reflex far removed from the umbo toward the periphery . . . . .	32	48	49	51	180	1.93	4.04	10.43	17.23	4.98
Color anomalies of the drumhead	Macular reflex <i>above</i> the short process . . . . .	11	12	5	5	33	0.66	1.01	1.06	1.69	0.91
	Punctiform, linear, or more expanded reflex <i>behind</i> the short process . . . . .	33	48	24	19	124	1.99	4.04	5.11	6.42	3.43
Form anomalies of the drumhead	Diffuse reddening or extravasation of blood . . . . .	4	4	3	4	15	0.24	0.34	0.64	1.35	0.42
	Serum perceptible in the drum cavity . . . . .	1	1	5	3	10	0.06	0.08	1.66	1.01	0.28
Form anomalies of the drumhead	Diffuse opacity . . . . .	19	27	20	12	78	1.15	2.27	4.26	4.05	2.10
	Circumscribed opacities . . . . .	173	172	79	33	457	10.43	14.47	16.81	11.15	12.65
Form anomalies of the drumhead	Calcifications . . . . .	22	12	11	10	55	1.33	1.01	2.34	3.38	1.52
	Posterior streak of opacity . . . . .	62	54	30	14	160	3.74	4.54	6.38	4.73	4.43
Form anomalies of the drumhead	Posterior fold . . . . .	60	81	67	61	269	3.62	6.81	14.26	20.61	7.42
	Manubrium mallei widened or short process projecting . . . . .	15	32	20	15	82	0.90	2.69	4.26	5.07	2.27
Form anomalies of the drumhead	Atrophy . . . . .	11	17	12	9	49	0.66	1.43	2.55	3.04	1.36
	Cicatrix . . . . .	11	25	19	15	70	0.66	2.10	4.04	5.07	1.94

TABLE XIX.—*Continued.*  
TOTAL NUMBER OF BOYS AND GIRLS FROM THE TWO PUBLIC SCHOOLS.

Hearing distance for whispered speech.		Number of auditory organs.				Total.	In percentages of each column.				Total.
		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.		Above 16 Metre.	16-8 Metre.	8-4 Metre.	4-0 Metre.	
Perforation of the drumhead	With otorrhœa	.	.	.	.	35	0.08	0.64	10.37	0.97	
	Without otorrhœa	.	.	.	.	35	0.30	0.59	1.91	4.73	
	Nasal speech	5	7	9	14	35	0.18	0.67	3.62	8.78	
	Former discharge	3	8	17	26	54	3.86	6.98	15.96	32.43	
	Former impaired hearing	64	83	75	96	318	1.90	5.21	8.30	28.04	
	Former tinnitus	33	62	39	83	217	2.11	2.61	5.11	6.42	
Former ear affections	Former earache	35	31	24	19	109	4.46	8.07	8.09	15.20	
	Former earache	74	96	38	45	253	21.70	24.64	24.89	29.73	
	Scarlatina	360	293	117	88	858	51.02	52.82	54.74	50.68	
	Morbili	363	628	256	150	1897	20.49	21.45	18.30	20.70	
	Rubeola	340	255	86	67	748	22.06	23.21	20.42	27.70	
	Diphtheria	366	276	96	82	820	1.81	1.93	1.28	1.01	
Other history	Meningitis	30	23	6	3	62	10.00	9.34	11.91	15.20	
	Trauma	.	.	.	.	2	0.43	.	.	0.06	
	Heridity	166	111	56	45	378	.	.	.	10.46	
	Not examined with speculum on account of disease, etc.	45	45	19	7	116	.	.	.	.	

Inasmuch as it became improbable from these figures that simple inspection from the mouth could give us sufficient data regarding the etiological connection of ear-diseases with pharyngeal affections, and as a thorough rhinoscopic examination was not feasible, I have abstained in the other two schools from a general examination of the pharyngeal space, and have merely noted the continual presence of nasal speech.

It would be quite erroneous if we were to expect that the deviations from the normal recorded in the table would be found *only* with more or less decreased hearing distance. On the contrary, it is well known that very great alterations may be present on the drumhead without any impairment of hearing being demonstrable. How frequent are the most various pathological conditions on the drumhead in the presence of normal hearing distance is shown by the figures in the following tables; they possess all the greater value, as the large rooms at my disposal permitted a more thorough test of the function than is possible in the physician's office.

It is a matter of great interest to ascertain from these figures how, in the face of many injurious influences, and despite many pathological alterations in its conducting apparatus actually present, our special-sense organ can maintain its full capacity; how its function is comparatively independent of a number of disturbances affecting the ear with special frequency.

As regards the significance of the several recorded alterations for the *diagnosis*, I should like first to call attention to the accidental occurrences which are of no importance for the function of the auditory organ, in order to show in connection therewith how, under these circumstances, the percentages gained stand in relation to the tabular arrangement chosen by us. For instance, if we consider the accumulation of cerumen, which only in part interfered with the examination, but left a certain lumen to the auditory canal, so that the hearing remained uninfluenced, the percentages in the whole five columns are nearly equal. This is the case also with the figures for the sulcus reflex,

and for a part of the preceding general diseases—rubeola, meningitis, and measles. Those with impaired hearing are here also frequently represented in slightly smaller percentages than those with normal hearing. The reverse is the case with the percentages of all those symptoms which clinical experience has taught us to be more or less characteristic of diseases of the auditory organ. The more rapidly and regularly the percentage numbers of a symptom increase from the column of the normal to the columns of successively worse hearing, and the more uniformly these relations are encountered in the tabulation of *all* the children, as well as in the *several* schools and the two *sexes*, the more essential for our diagnosis may we regard the symptom in question; nay, we are justified in designating the relations found in this manner as actually the numerical expression of the diagnostic significance of the several symptoms.

In the same way could be determined also the etiological importance for ear affections of the other local and general diseases taken into consideration, and, finally, the tables give us some information as to the influence of heredity on diseases of the ear.

In order to facilitate matters, I shall in the following pages place together, in the discussion of every single symptom or etiological factor, the series of numbers found in the three schools and the two sexes with the total figures of table XIX., so as to show in how far the relations prove constant even with a limited amount of material.

*(To be concluded.)*

## REPORT ON THE PROGRESS OF OTOTOLOGY IN THE SECOND HALF OF THE YEAR 1884.

Translation by DR. JEFFERSON BETTMAN, New York, Assistant Surgeon to  
the N. Y. Ophthalmic and Aural Institute.

### I.—NORMAL AND PATHOLOGICAL ANATOMY OF THE ORGAN OF HEARING.

BY DR. H. STEINBRÜGGE,

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1. Prof. E. ZUCKERKANDL. Contributions to the anatomy of the organ of hearing. (a) Ossification of a circumscribed portion of the lateral cartilaginous wall of the Eustachian tube. (b) Reticular cartilage at the hamulus pterygoideus.

2. Prof. PAUL ALBRECHT. On the morphological importance of the Eustachian tube, the origin of the palatine, mandibular, and hyoid arches in the Vertebrates, followed by a demonstration that the "symplectico-hypomandibular" is morphologically independent of the hyoid arch. A communication to the Society of Pathological Anatomy at Brussels, May 11, 1884. Thirteen illustrations elucidate the text.

3. Prof. E. ZUCKERKANDL. The erectile tissue of the nasal mucous membrane, and its relation to the respiratory fissure. *Wiener med. Wochenschr.*, No. 38, 1884.

4. Prof. PHILIPP STÖHR. Tonsils and sebaceous follicles. *Virchow's Archiv*, Bd. xcvi., p. 211.

5. Dr. GUSTAV BICKEL, of Wiesbaden. The extent and relation of lymphatic tissue in the pharyngeal region. *Virchow's Archiv*, Bd. xcvi., p. 340.

6. Dr. ALFRED NOBILING, of Munich. Pathological ob-

servations in cases of death due to asphyxia in the new-born, and their medico-legal bearing. *Bayrisches ärztl. Intelligenzblatt*, 1884.

1. ZUCKERKANDL (1, a) found a small piece of bone, the size of a hemp-seed, in the anterior wall of the Eustachian tube of a man, the pharyngeal orifice being in other respects quite normal. The spicula was firmly adherent to the mucous membrane, and the author regards it, similar to analogous cases already published by Moos, as a circumscribed ossification of the cartilage. Under peculiar circumstances this may have caused some difficulty in attempted catheterization of the Eustachian tube. The presence of accessory cartilaginous plates in the floor of the tube, in the pharyngeal prominence, in the lateral walls, and in the ligaments connecting the cartilaginous portion of the tube with the vault of the pharynx, is so frequent an occurrence as to be considered a normal condition. They have but little practical bearing as long as ossification has not set in.

(1, b) The point of the hamulus pterygoideus consists of a fibro-cartilaginous process, which constitutes  $\frac{1}{4}$  to  $\frac{1}{3}$  of the entire length of the hamulus. Cross-sections of the process reveal a dense, fibrous tissue at the periphery, more loosely bound and enclosing isolated cartilage cells toward the centre.

Numerous cartilage cells embedded in a striated basis-substance, occupy the yellow-stained centre. The latter, after treatment with a ten-per-cent. potash solution, was found to consist of elastic tissue. The hamular process is accordingly composed at its periphery of fibrous tissue and fibro-cartilage; the centre, of reticulated cartilage. As yet the physiological function of the process is unknown.

2. The author alludes to his deductions, already published, that the maxillary joint of mammals is homologous to that of the lower gnathostomes. He, furthermore, concludes, that the ossicles of the ear in mammals represent the columella of birds and reptiles; the latter again, the so-called symplectico-hypomandibular arch of fishes. According to ALBRECHT'S researches, the last mentioned is genetically independent of the hyoid, it being a part of the dorsal portion of the mandibular arch.

3. The ethmoid bone is much more developed in carnivora than in the herbivora, although the length of the turbinated bones is greater, and the presence of the erectile tissue acts compensatorily



for this want of development in the latter. In human beings this condition is very marked. Here not alone the anterior and posterior extremities of the turbinated bones, but also the medial surface and the free border of the middle turbinated bone, are covered with erectile tissue. The shape of the turbinated bones increases the area of mucous membrane, and the overlying cavernous tissue reduces the nasal fossa to a fissure the size of which is dependent on the more or less turgid state of the erectile tissue. An abnormal width of the respiratory fissure, a condition existing in *ozæna*, favors pathological influences in reducing the area of mucous membrane, and in permitting the entrance of too great a volume of air in nasal respiration. That part of the mucous membrane overlying the erectile tissue is thick, and contains numerous striped muscle-fibres. The cavernous tissue in its superficial layer is composed of a reticulum of fine venous channels, which becomes more extensive in the deeper layer. A turgescence of these tissues can produce sudden changes in the width of the respiratory fissure. The periosteal portion of the mucous membrane contains the efferent vessels. The arteries generate three capillary systems: a periosteal, a glandular, and a superficial net. In closing remarks, the author dwells upon the reflex neuroses arising from the turgid state of the erectile tissue, a condition first thoroughly described by Hack.

4. The mucous membrane of the mouth and pharynx, covered with pavement-epithelium, contains adenoid tissue in various parts of its folds and recesses. Masses of leucocytes, which abound in this adenoid tissue, migrate through the layer of epithelium and appear on the surface of the mucous membrane as mucous and salivary corpuscles. This is no pathological, but a normal process. The leucocytes migrate through the cement substance, slightly pushing the epithelia aside. In the passage between the cells the protoplasm of these amoeboid corpuscles becomes elongated, the nucleus but rarely changing its shape. The author has observed that, within and on the surface of the epithelial coat, multiple division of the nuclei, as if due to some general and sudden cause, takes place. The leucocytes always seek the shortest route in their migrations. The author has observed these changes in the tonsils of cats, rabbits, porcupines; again, in cattle, sheep, pigs, dogs, moles; and lastly, in the follicles of the tongue and tonsils of healthy human beings.

He found these corpuscles heaped up in masses, surrounding the mouths of the mucous follicles in the case of a child three months old. In adults, the epithelia lining the acini are filled with leucocytes, whilst but few are found in the epithelia covering the base of the tongue. Migration does not take place equally in all parts, as certain epithelial tracts in the fissures of the tonsil and on its surface contained more leucocytes than were found in other portions of the tissue. The leucocytes were never observed to have penetrated into the interior of the epithelial cells. In all probability in more advanced stages, this extensive subepithelial infiltration produces a destruction and subsequent regeneration of the epithelial layer. Migration of these cells begins at birth, and if not influenced by disease continues during life. In closing, the author dwells upon the practical signification of this process; the inter-epithelial spaces produced by the passage of leucocytes may serve as points of entrance for infectious micro-organisms.

5. The author attempts to define the extent of adenoid tissue in the pharyngeal region, and to decide to which structures the term "tonsils" in the true meaning is applicable. His conception of a tonsil is as follows: (*a*) A circumscribed shape; (*b*) a crowded, diffuse infiltration of lymphoid cells containing agglomerations of small lymphatic follicles; (*c*) crypts; (*d*) the extension of adenoid tissue close to the epithelial layer. The author leaves undecided whether or not acinous glands are necessary in the definition of a tonsil. Excluding the faucial tonsils, this term ought accordingly merely be applied to the "pharyngeal tonsil." The follicles surrounding the opening of the tube, and situated at the root of the tongue, represent structurally a transitorial change into a simple conglomeration of adenoid tissue. He reviews the literature on this subject from the time of Vesalius up to modern date, and appends the results of twenty-four autopsies, these embracing subjects of both sexes and at various ages.

In dwelling upon the extent of lymphatic tissue, the author confirms the presence of the "pharyngeal adenoid zone" described by Waldeyer. This, including the pharyngeal tonsil, extends laterally to the tissue surrounding the pharyngeal orifice of the tube, involving the posterior border of the velum, continues posterior to the palato-pharyngeal fold, to the faucial tonsil, and crosses the base of the tongue to the other side. The personal researches of the author include the study of the adenoid tissue surrounding this zone, and the development of the various

varieties of tonsils. During the foetal period, and in the first year after birth, the pharyngeal tonsil is represented by a pouching in of the mucous membrane. Later on in life, a pad-like prominence develops from the bottom of this pouch. The development of the follicles at the root of the tongue takes place inversely; their presence being primarily represented by ridges which subsequently disappear, leaving distinct pouches. The presence of lymphatic tissue in the pharynx, around the openings of the tubes, is at first indicated by a series of fine longitudinal folds; a condition also noticeable on the anterior and posterior surfaces of the soft palate. These folds generally disappear during the first year after birth. In individual cases they remain in the faucial tonsils, and in the collection of adenoid tissue surrounding the tubal orifices. These folds are profusely infiltrated with lymphatic elements.

Besides the large lymphatic zone, the author demonstrates the presence of a second and smaller one, composed of the faucial tonsils, of the follicles at the base of the tongue, and of the adenoid tissue in the soft palate. Extending from this circle, the adenoid tissue radiates, in varying amount and frequency, along the floor of the mouth, over the posterior surface of the velum into the nasal fossæ. In the latter location it extends along the lower and middle meatuses to the anterior extremity of the inferior and middle turbinated bones. Occasionally, involving the epiglottis, it extends into the larynx. The author also alludes (*vide* this Review 4) to the susceptibility of these structures to the absorption of infectious material. This condition is probably regulated by the varying arrangement of the lymphatic structures in different individuals.

6. NOBILING studied the pathological changes following asphyxia in the bodies of 173 new-born infants, at, or almost at, full term; further those of 138 decomposed foetuses, varying in the period of development from the seventh to the ninth month; and those of 142 foetuses from the fourth to the end of the seventh month in age. Many of the latter had lived some time after premature delivery. In reviewing, merely those changes involving the ear and the naso-pharyngeal space are considered. The auricle, external meatus, and the external layer of the membrane present no lesions. Hemorrhages are always traumatic in origin. The vessels of the tympanic cavity and the lining of the tube are always highly engorged, the mucous membrane presenting punctate hemorrhages. The latter may induce a slight elevation or thickening of the

membrane. At times hemorrhages take place into the middle ear. The appearance of both tympanic cavities varies considerably in individual cases. If asphyxia has taken place in a fluid medium, some of it will be found in the middle ear. The labyrinthian fluid is often reddish in tinge, due to the presence of blood-corpuscles. The inner surface of the plate of the stapes is markedly injected, and at times the fluid contents of the cochlea are also tinged with blood. The body of the tensor-tympani muscle is striated by fine, linear, bloody extravasations. This, excluding a similar condition in the ocular muscles, is found in no other muscles of the body. The nasal mucous membrane is intensely congested, that part covering the turbinated bones much thickened and the seat of mucous extravasations. Extensive ecchymoses are found in the mucous lining of the tubes, choanæ, and pharynx. Hemorrhages often take place into the naso-pharynx. Œdematous thickening of the nasal mucous membrane has also been observed. In aspiration the blood may be sucked into the alveoli of the lung.

## II.—PATHOLOGY AND THERAPEUTICS OF THE EAR.

BY A. HARTMANN, OF BERLIN.

### GENERAL.

1. Dr. BEZOLD, of Munich. Report of cases of ear trouble treated from 1881 to 1883 inclusively. *Arch. f. Ohrenheilk.*, Bd. xxi., p. 221.

2. BEZOLD. Report of ear cases treated clinically from 1881, including 1883. *Aerztl. Intelligenzbl.*, No. 49., 1884.

3. Dr. WAGENHAEUSER, of Tübingen. Aural report of the Polyclinic at Tübingen of cases treated from the 1st of April, 1883, to the 1st of April, 1884. *Arch. f. Ohrenheilk.*, Bd., xxi., p. 267.

4. Dr. JACOBSON, of Berlin. Report of ear cases treated in the University clinic at Berlin from April 1, 1881, to April 1, 1884. *Ibid.*, p. 276.

5. Dr. BÜRKNER, of Göttingen. Report of ear cases treated in the Polyclinic at Göttingen during the year 1883. *Arch. f. Ohrenheilk.*, Bd., xxi., p. 169.

6. Dr. KIRCHNER, of Munich. Aural diseases in diabetes

mellitus. *Monatsschr. f. Ohrenheilk.*, No. 12, 1884 ; compare with our report of the Congress at Basel, p. 159.

7. A. DREYFUSS. Recent observations relating to mumps. *Gazette hebdom. de méd. et de chirurg.*, No. 30, 1884.

8. Dr. AUGUST LUCÆ, of Berlin. The origin and treatment of subjective tinnitus aurium. Verlag von Otto Enslin, 1884.

9. Dr. SAMUEL SEXTON, of New York. Hallucinations of hearing and faulty audition in musicians and singers, occasioned by autophony in diseases of the ear. *Revue mens. de laryng., d'otol., etc.* No. 11, 1884.

10. Dr. F. ROHRER, of Zurich. A case of sudden deafness after measles. *Correspondenzbl. für Schweiz. Aerzte*, 1884.

11. Prof. ZAUFAL. Use of cocaine, in otology. *Prager Med. Wochenschr.*, No. 47, 1884.

12. Drs. E. J. MOURE and J. BARATOUX. The use of the chlorhydrate of cocaine as an anæsthetic of the pharyngeal, laryngeal, and nasal mucous membranes, and in the treatment of diseases of these organs and of the ear. *Revue mens. de laryng., d'otol., etc.*, No. 12, 1884.

13. LEARTUS CONNER. Mumps as a cause of sudden deafness. *Amer. J'n'l Med. Sci.*, Oct., 1884.

14. G. F. HAWLEY. The effect of noise upon certain forms of deafness. *N. Y. Med. Record*, July 5, 1884.

15. Dr. S. SEXTON. A handy pocket-ear-cure.—*N. Y. Med. Record*, July 12th.

16. W. A. BARTLETT. Pain in the ears due to irritation in the jaws. *N. Y. Med. Record*, Oct. 4, 1884.

1. BEZOLD publishes a tabular report, with special reference to therapeutical results, of 2,569 ear cases treated in his private practice from 1881 to the end of 1883. A second report embraces 3,846 patients treated in both his private and clinical practice. On studying the reports, the small number of children affected by non-perforating chronic middle-ear affections is striking. The same condition exists in dysacusis, as yet not clearly defined, and attention is further directed to the bilateral appearance of this symptom. A review of the statistics demonstrates the relation of subjective tinnitus, vertigo, and heredity in chronic non-suppurative affections of the middle and inner ears. It is shown that

heredity is the dominating factor in those cases of deafness where pathological changes are assumed to have affected the labyrinthian fenestræ and to have produced an immobility of the contingent structures. In reference to sex and age, the determining cause of these affections must be sought for in conditions existing mainly in members of the male sex of more advanced ages.

Table IV. reviews the intensity and duration of the diseases affecting various parts of the ear due to scarlatina. In addition to this he compares the otorrhœæ occurring in scarlatina, diphtheria, and measles, and demonstrates that in both of the latter combinedly not one fourth the number of ear complications result as in scarlatina. Simple, acute, and subacute inflammations and chronic purulent conditions of the middle ear occurring in syphilis are attributed by the author to primary affections of the nose and the naso-pharynx. In closing, the author arranges all the cases of acute and subacute affections of the external and middle ears observed during the period 1881-1883, with special reference to the exact month of the time of the attack. According to this, thermometric and barometric changes seem to exert a decided influence on the course of so-called acute and subacute catarrhs of the middle ear,—a condition quite at variance to that induced in cases of acute suppurative affections. The deductions of the above lead to the inference that climatological influences either affect the course of middle-ear catarrhs differently from that in purulent conditions, or that the development of the latter is perfectly independent of these influences.

2. BEZOLD's second report relates to 1,277 ear cases treated in the Policlinic during the term 1881, to and including 1883. Of these, 328 were external ear troubles, 840 affections of the middle ear, and 94 diseases of the inner ear. Expressed in percentages, affections of the external ear composed 26.0, of the middle ear 66.6, and of the inner ear but 7.4. Comparisons with similar statistics of private cases induce the author to regard this relative percentage of diseases affecting various parts of the ear as a standard. This proportion is not influenced by the grade of the class of patients, by seasons, or by atmospheric and telluric conditions. Aspergillus growths in the external meatus occur less frequently in clinical than in practice of a higher social plane. However, eczema of the auricle and the auditory meatus occurs more often, and cases of inspissated cerumen by far most frequently, in the former.

The ratio of cases of traumatic rupture of the membrane is double in clinical to that of private practice. The author's statistics also show that affections of the tube, especially those affecting children, are more numerous in private practice. The same condition exists relative to subacute catarrh of the middle ear, whilst contrarily, cases of acute middle-ear catarrh are more numerous in the clinic.

There is no variance in the relative number of cases of acute middle-ear catarrh and acute purulent inflammation either in private or clinical practice, but instances of chronic purulent otitis media occur more often in the clinic. Perforations of Shrapnell's membrane and cases of cholesteatoma of the middle ear are observed more often in private practice. Regarding diseases of the inner ear, the author finds that, comparatively, cases of unilateral deafness, and especially impaired hearing and deafness, due to traumatism, occur relatively more often in clinical practice. Contrarily, cases of subjective tinnitus without any impairment of hearing and of nervous deafness seem to prevail in private clientèle. The author has noticed several cases of acute otitis media purulenta arise during the course of erysipelas, and he describes *in extenso* the clinical features of one of these cases.

One case of acute suppuration of the middle ear, originating during an attack of abdominal typhoid, was also observed. Judging from the history of this case, it is seen that even mild forms of suppuration occurring in typhoid may, in certain conditions, exert some influence upon the general constitution. Two cases of purulent middle-ear disease ended fatally. In two cases, sequestra were removed. The one, occurring in a child one and a quarter year old, of inherited syphilitic taint, included the whole unchanged tympanic ring. In the second case, that of an infant fourteen months old, the extracted sequestrum was composed of the greater part of the cochlea and its surroundings.

3. During the term April 1, 1883, to April 1, 1884, 391 ear patients were treated in the Policlinic at Tübingen. One case of hemorrhagic otitis externa presents interesting features, as the patient became delirious, and suffered from hallucinations. This case goes to show that severe inflammation of the external meatus may produce cerebral symptoms without any direct involvement of the middle ear.

Amongst the cases of parasitic growths, the author observed and describes a new form of aspergillus, the *mucor coymbifer*.

This form of aspergillus is characterized by the umbelated arrangement of the sporangia, by small, colorless, pear-shaped heads, by a brownish top-shaped columella, and by the minute, colorless, elongated spores.

4. In reviewing the 240 varieties of disease occurring during the first three years' existence of the aural department of the University clinic at Berlin, the author devotes special attention to those forms in which subcutaneous injections of muriate of pilocarpin had been instituted as a mode of treatment. These embraced thirty-five cases of disease of the sound-perceiving apparatus, in which it was expected that energetic stimulation of the sudoriferous and salivary glands would induce absorption of exudatious or non-organized inflammatory products in the inner ear. In twenty-four cases no appreciable improvement followed, five were slightly improved, whilst in but six a marked increase in the range of audition was observed. Although the general results were not very favorable, Jacobson advocates further trials of these pilocarpin injections, and recommends their use in those forms of deafness presenting no conclusive evidence of involvement of the acoustic nerve, and in which inflations and injections into the middle ear had been attended by little or no improvement. It is possible that more recent cases of the latter type may be considerably improved by this mode of treatment.

Thirty-one operations upon the mastoid process were attended by but one fatal result. In this isolated case, cerebral complications were already so pronounced at the time of operation as to render death inevitable. The remainder of the report is devoted to clinical notes, and in closing, the author encourages the use of several of the recent more popular medicinal agents. Chlorinated water is highly spoken of as an energetic disinfectant in preference to boracic acid. It not only produces a rapid decrease in the amount of secretion, but exerts a caustic effect on small granulations and polyps. In the removal of dessicated or cholesteatomatous matter, he advises syringing with equal parts of water and alcohol. The use of this mixture will prevent soaking and swelling of these masses.

5. Excluding 58, who had been discharged after one or more examinations, 812 ear patients were treated at the Policlinic, at Göttingen, during 1883. A case of hemorrhage into the tympanum, induced by a fit of coughing in a phthisical patient, is described in detail. Other cases of interest are, one of rupture



of the tympanic membrane, produced by a kiss on the ear, another of clonic spasms of the tensor-tympani muscle, occurring in a patient suffering from marked catarrh of the Eustachian tube. The author was able to corroborate the statements of a locomotive engineer, who experienced a loud cracking and at the same time a slight movement in the right ear every time he heard the steam-whistle. On producing a noise by scratching a pane of glass with a knife, these sounds became audible to the observer. The cases of three glass-blowers are of some interest, as all three suffered from similar subjective tinnitus, constant and singing in character, without presenting any visible lesion. In all three this symptom disappeared on abandoning its cause—their trade. The author attributes these subjective noises to a condensation of the air in the tympanic cavity, with subsequent increase of intra-labyrinthian pressure, and to a state of congestion induced by the retention of air in the forcible expirations. Basing his experience on fifty cases, the author highly recommends the use of sulphate of atropine as a very efficient anodyne in painful diseases of the ear, and inclines to the belief that it exerts a direct influence on the peripheric sensory nerves.

7. DREYFUSS adds two more cases, occurring in his own experience, to the thirteen cases described by Lemoine and Lannois, and the additional three published by Buck, of New York, of unilateral deafness following mumps. He shares the opinion that many cases of temporary deafness or impairment of hearing following mumps are overlooked by parents, and that probably many cases of unilateral deafness not attributable to any direct cause date their origin from a preceding attack of parotitis. According to him, aural troubles set in usually a few days after the onset of the main trouble; in both his cases, not till twelve days after recovery from a mild attack of mumps. Cases are recorded, however, where aural trouble preceded the attack of mumps by two to three days. The aural complications are generally ushered in by rushing, hissing tinnitus and more or less pain in the ear. Later on the train of Ménière's symptoms, such as vertigo, nausea, and vomiting set in. Convulsions or loss of consciousness have, however, never been noticed. In both the author's cases the aural disorder was merely preceded by a feeling of malaise and lassitude. Deafness develops very rapidly, in a few hours, never later than within two to three days, while the membrane, pharynx, and Eustachian tube are to all appearances perfectly

normal. The author does not share the opinion of Lemoine and Lannois, that deafness is always irremediable, as hearing power was almost entirely restored in one of his cases. Dreyfuss entertains views similar to those of Brunner, that the pathological changes consist in an exudation into the labyrinth, with subsequent atrophy—changes resembling those occurring in the testicle in attacks of mumps. He rejects the assumption as not being tenable, especially in those instances where aural complications arise prior to or after the general attack, that the process is an inflammatory extension from the parotid gland along the facial nerve or through the Glaserian fissure. Furthermore, the rapid development of the deafness would not favor this hypothesis.

The author thinks that we have to deal here with a localization (metastasis) of the morbid products independent of the usual limits of parotitis. Not only the lymphatic, salivary, and seminal glands, but also the organs of special sense are affected in parotitis. The disturbances in the auditory organ are analogous to those which have recently, from the same origin, been noticed in the visual organ—namely, conjunctivitis, amblyopia, and optic neuritis.

8. The publication of LUCÆ, treating of the relation of subjective tinnitus to external sounds and of the dependence of troubles of hearing on subjective tinnitus, tends to the conclusion, that the latter is more often induced, than hitherto recognized, by external sounds. Inversely, however, the author has frequently been able to check or ameliorate the tinnitus through the action of external sounds. In reference to the relation of impaired audition to the subjective tinnitus, the observer has noticed, that immediately after the cessation of the latter a marked improvement in hearing takes place.

To elucidate his views, the author has classified the various forms of tinnitus into two main divisions. The first division includes those forms of tinnitus, the intensity of which is increased by the action of external sounds; the second, in which a similar action produces a diminution. The first category usually embraces those cases in which the tinnitus is produced by repeated, prolonged exposure to sound, as in the case of musicians, amateurs, and artisans of various crafts. Means should be adopted to shield this class of patients from the action of external sounds. To enforce this, it is necessary to completely plug the affected ear, to evade exposure to the sounds producing the tinnitus, and,

analogous to the dark-room treatment adopted by oculists, to reside in a vicinity as free as possible from noises and sounds.

In those cases, also, where aural disturbances are attributable to a sudden violent concussion, and in which the tinnitus is not aggravated by external sounds, in connection with an existing impairment of hearing and great sensitiveness to certain sounds, a strict adherence to the above-mentioned régime will often produce improvement in hearing and amelioration of the tinnitus. Both the author and Urbantschitsch have made the observation, that in many cases of subjective tinnitus the application of a vibrating tuning-fork will frequently produce a marked temporary amelioration, occasionally an entire suspension, of the symptom. The author has utilized this observation in the treatment of those numerous cases, in which the subjective tinnitus is more or less marked by external sounds. Based upon the favorable results produced in a case of tinnitus of a high-pitched whistling character by the low rumbling of vehicles, he institutes a methodical treatment, using objective sounds opposite in pitch to that of the subjective tinnitus. Tinnitus, high in pitch, such as hissing or ringing, was treated by low tones ( $C_1$ ,  $C$ ); whilst inversely, low, rushing, and roaring tinnitus, by objective tones high in pitch ( $C^3$ ,  $C^4$ ). In many cases this treatment was followed by an immediate or gradual improvement; the tinnitus generally persisting a brief period, in some instances, a few days, after the suspension of this mode of treatment. A surprising improvement in hearing power was at the same time noticeable in many of these favorable cases. The range of audition increased several metres and continued to improve for months, even after the treatment by sounds had been discontinued.

9. SEXTON's publication treats of three cases of auditory hallucinations and faulty perception of musical tones and noises. Ménière's symptoms co-existed in the first two cases, whilst varying deafness, due to nasal catarrh, complicated the third case. Sexton restricts the clinical description of these cases to the subjective symptoms of the patients, without mentioning any physical conditions, especially those relating to the Eustachian tubes. The symptoms enumerated consisted of impaired hearing, faulty perception of vocal and instrumental tones, and auditory hallucinations. The third case was marked by deafness for ordinary tones and <sup>1</sup> "l'autophonie à tel point qu'il lui était impossible de

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<sup>1</sup> Such marked autophony that the patient was unable to distinguish the notes of the piano.

distinguer les notes du piano." The description of these cases forces the inference that Sexton's interpretation of the term "autophony" is entirely at variance with that universally accepted, *i. e.*, hearing one's own voice through the Eustachian tube.

10. ROHRER publishes a case of complete bilateral deafness occurring suddenly, in a girl aged twelve years, eight days after an attack of measles. In connection with this mental depression, sluggish action of the pupils and occasional tinnitus aurium were also present. Physical examination revealed a normal state of the ear and intumescence of the nasal and pharyngeal mucous membranes. Inflation of the middle ear produced no palpable difference. Later on, epileptoid spasms followed attacks of violent headache, and disorders of speech and vision also supervened. Three weeks after the onset of the deafness, former hearing power was suddenly restored. Rohrer inclines to the belief that the co-existing naso-pharyngeal catarrh may have induced the preliminary impairment in hearing. Complete deafness, in connection with profound nervous disturbances in general, and the involvement of the acoustic nerve, would indicate central changes.

11. ZAUFAL was able to make a thorough naso-pharyngeal examination five minutes after painting the lower surface of the soft palate, the posterior wall of the pharynx, and the base of the tongue, with a five-per-cent solution of cocaine. Similar attempts in the case of a boy, aged twelve, after an application of a ten-per-cent. solution, were futile. Three minutes after application of a five-per-cent. solution to the nasal septum and lower turbinated bone, the touches of a probe produced no irritation, and the pricking of a paracentesis needle was not noticed. Three drops of a two-per-cent. solution were instilled into the auditory meatus, and twenty-seven minutes later the membrane was rendered so anæsthetic as not to feel the touch of a probe; the only indication was the subjective noises caused thereby. In another case, four drops of the same solution produced complete loss of sensibility of the membrane, and lower wall of the osseous meatus in twenty-one minutes. Four drops of the same solution were instilled into the right ear of a female patient suffering from subjective tinnitus due to anæmia. Five minutes later the woman experienced a ringing noise, alternately, in both ears. After a lapse of twenty minutes the anterior segment of the membrane was rendered so anæsthetic, that the noises consequent upon the touch of the probe, were experienced more distinctly than the touch itself. After

thirty-five minutes this part of the membrane was completely anæsthetic to touch, nothing but the noises being perceived. During this entire period the posterior half of the membrane was uniformly sensitive to the touch. These favorable results are, however, qualified by equally numerous negative attempts. In the case of a man, aged fifty-four, an application of a ten-per-cent. solution for twenty-two minutes, did not produce the slightest change in the sensibility of the membrane and the auditory meatus. Zaufal also noticed that probing did not produce any hyperæmia after the use of cocaine. In fact, previous congestion seemed to disappear after its use. A few drops of a two-per-cent. solution were instilled through a perforation of the membrane into the middle ear, and after twenty-five minutes the parts were so benumbed that the touch of the probe on the promontory was not felt. In the case of a boy, aged ten, the use of a five-per-cent. solution reduced the sensibility sufficiently to permit the snaring and removal of a granulation from the tympanic cavity, without any resistance or calling forth pain. In another case, in which the removal of a granulation was exceedingly painful, the remainder of the operation was painlessly performed, after instilling a few drops of a five-per-cent. solution into the ear.

12. MOURE and BARATOUX have derived benefit from the use of cocaine in acute inflammatory affections of the ear. They have also used it in coryza, and with marked benefit in two cases of otorrhœa which had resisted the usual mode of treatment. After application of a ten-per-cent. solution, both nasal and aural polyps were painlessly removed. Galvano-caustic operations on the tonsils and in the nose were rendered painless, after a previous use of three-per-cent. or five-per-cent. solutions of cocaine.

13. In addition to a general review of the whole subject, with abstracts of the already published cases, C. relates one case. The patient was a girl who, a month preceding the examination, had had mumps. As the attack was subsiding she was suddenly seized with dizziness, staggering, nausea, and vomiting. Seen four days afterward, she was in bed on account of the nausea and giddiness. Temperature and pulse normal; tongue coated. After the action of some calomel powders the nausea and dizziness disappeared, but a deafness in the right ear remained. When tested by C., there was no perception of sound by the watch, tuning-fork, or Politzer's acoumeter. Inflation made no change. *Mt* indicated a past inflammation of the middle ear. Hearing in

L,  $\frac{3}{8}$ ; condition of *Mt* same as R. Pharyngitis. Examined four and a half months after, the hearing in L was  $\frac{4}{8}$ ; increased by inflation to  $\frac{4}{8}$ . R still in same condition as regards watch, but the tuning-fork is heard on bone and also at a distance of four inches from the ear; the acoumeter, at two inches. The author thinks it probable that the disease extended from the parotid gland through the middle ear to the labyrinth.

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14. H. believes that the impaired hearing which is improved by noise is due to (1) a relaxed condition of the *Mt*, or (2) a destruction of the proper relation between it and the stapes. A loud noise, he thinks, overcomes these conditions.

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15. Description and figures of the various instruments. The case is manufactured by Caswell, Hazard, & Co., N. Y.

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16. The cases, eight in number, are from Dr. Sexton's aural service at the N. Y. Eye and Ear Infirmary. In all, diseased teeth were found, and "very soon after, a cure was effected by the extraction of the diseased teeth."

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#### EXTERNAL EAR.

17. Dr. BARTSCH, of Parchim. A case of perichondritis auriculæ. *Monatschr. f. Ohrenheilk.*, No. 12, 1884.

18. Dr. LOUIS BLAU, of Berlin. Two rare diseases of the external ear. *Berliner klin. Wochenschr.*, No. 33, 1884.

19. Dr. MÉNIÈRE. Acute mastoid periostitis. *Revue mens. de laryng.*, *d'otol.*, etc., 1884, p. 224.

20. Dr. NOQUET, of Lille. Foreign bodies in the ear. *Ibid.*, p. 220.

21. Dr. GELLÉ, of Paris. Circumscribed periostitis of the external meatus.

17. The case of perichondritis described by BARTSCH affected the posterior convex surface of the auricle. It was characterized by a soft, flattened swelling the size of a bean, the skin covering it being of a bluish-red discoloration. Several fistulous tracts were also present, and the cartilage was exposed and roughened. The patient was chloroformed, the fistulous tracts slit open, and all morbid tissue curetted with Wolff's sharp spoon; rapid recovery ensued.

18. BLAU describes a case of isolated spasm of the auricular muscles occurring in a boy aged ten years. Coëxisting there were occasional paroxysms of sudden pain in both ears, and hyperæsthesia of both auricles and external meatuses to the slightest touch. Treatment consisted in narcotic embrocations to the hyperæsthetic parts and plugging the ears with cotton. This was soon followed by complete cure. Blau attributes the spasm to an irritation of the auricular branches of the facial nerve, caused by reflex action of the sensory filaments of the trigeminus distributed in the external ear.

He further describes a case of diphtheria of the external meatus following measles. During the period of desquamation, the patient suddenly experienced severe pain in the left ear, impairment of hearing, and subjective tinnitus. Diphtheritic membranes began to form and soon covered the membrane and the walls of the meatus. No perforation of the membrane existed. A treatment with warm-water applications, syringing with solutions of boracic acid, and the use of the latter as a powder, was instituted. Eleven days after, tonsillar diphtheria developed, but recovery soon took place. Fully three weeks elapsed ere desquamation had ceased in the external meatus. This is the first instance of diphtheria of the external meatus following measles on record. Blau prefers his mode of treatment to that of Burckhardt-Merian, which consists of cauterization and the forcible removal of the membranes.

19. MÉNIÈRE refers to a previous publication in 1879, and erroneously<sup>1</sup> claims priority of first calling attention to the complication of inflammation of the external meatus in mastoid periostitis. He advocates a free incision down to the periosteum of the mastoid process.

20. NOQUET describes the removal of a foreign body from the ear by repeated syringing.

21. GELLÉ, basing his observations on five cases, describes an affection involving the external meatus, which he entitles "otite externe périostique circonscrite." This affection, which must not be confounded with furuncles of the external meatus, always ends in resolution under the action of emollients. According to his description, it is rheumatic in nature, generally affects both ears simultaneously, and is usually accompanied by a rheumatic inflammation of the fauces.

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<sup>1</sup> Vide Hagen : "Die circumscribte Entzündung des äusseren Gehörganges," Leipzig, Veit and Comp., 1867, pag. 22.

THE MIDDLE EAR.

22. C. MIOT. The action of the neutral sulphate of atropine upon the course of acute inflammations of the ear in children. *Revue mens. de laryng., d'otol., etc.*, No. 8, 1884.
23. SAMUEL SEXTON. On the treatment of a case of acute catarrhal inflammation of the middle ear by removal of accumulated secretions from the tympanum through the Eustachian tube. *The Lancet*, Oct., 18, 1884.
24. W. MEYER. The nature of chronic suppurations of the tympanic cavity. *Archiv f. Ohrenheilk.*, Bd. xxi., page 149.
25. DR. A. EITELBERG, of Vienna. The treatment of otorrhœa with solutions of corrosive sublimate. *Wiener med. Presse*, 1884.
26. DR. RAFAEL ARIZA. Suppurative inflammation of the middle ear and its treatment. Madrid, 1884.
27. JOH. NATHAN. The presence of the bacilli of tuberculosis in otorrhœa. Inaug.-Dissert.
28. ARTHUR NEVE. Disease of the mastoid cells, operation by incision and gouging, recovery, remarks. *The Lancet*, Sept. 20, 1884.
29. PROF. ZAUFAL. Thrombosis of a sinus following otitis med. supp. *Prager med. Wochenschr.*, No. 48, 1884.
30. DR. DELSTANCHE, of Brussels. The treatment of atrophic catarrh of the middle ear (sclerosis). *Annales des mal. de l'oreille*, etc., 1884, page 335.
31. DÉJERINE. Compression of the chorda tympani. *Progrès médical*, No. 33, 1884.
32. DR. JOH. HABERMANN, of Prague. Tenotomy of the stapedius. *Prager med. Wochenschr.*, No. 44, 1884.
33. DR. REEVE. Brief remarks upon fifty cases of trephining Trof the mastoid. *ans. Med. Assoc. of Canada*, 1884.
34. W. A. BARTLETT. Neglected otitis media purulenta following vaccination and complicated with caries and necrosis of the mastoid; illustrating the favorable termination of the diseases without active interference. *N. Y. Med. Fourn.*, Sept. 13, 1884.
36. C. J. LUNDY. The dry treatment of chronic suppurative inflammation of the middle ear. *Med. News*, July 5, 1884.
36. C. S. TURNBULL. Does a chronic discharge from the ears make life insurance hazardous? *Trans. Med. Soc. of Pa.*, 1884



22. M<sup>1</sup>OT has used solutions of atropine in his clinic in the treatment of children suffering from acute coryza with ear complications. He found its action extremely efficient in controlling the inflammation in the nose and preventing its extension to the ear. To exemplify, he selects out of thirty observations the case of a four-year-old girl who had suffered repeatedly from attacks of acute nasal catarrh with accompanying pain in the ears. The immediate use of two to four coffee-spoonfuls daily of a solution of atropine (gr.  $\frac{1}{8}$  ad  $\frac{3}{4}$  iiss.) prevented aural complications in subsequent attacks of coryza.

23. SEXTON describes a case of acute inflammation of the middle ear, occurring in the person of Prof. Bryant, with marked deafness, vertigo, nausea, tinnitus, and autophony. Examination revealed a marked bulging of Shrapnell's membrane, due to a collection of secretion in the upper part of the drum cavity. Sexton, after introducing a flexible catheter into the Eustachian tube, removed the fluid by the suction of a syringe. Immediate improvement followed.

24. According to MEYER, the granulations so frequently seen covering the labyrinthian wall of the middle ear in cases of chronic purulent catarrh, always cover exposed bone. Even on disappearance of these granulations, the exposed bone may be suspected by the presence of a small scab and can be detected by the touch of the probe. If complete restoration of the soft parts has taken place, the exposed osseous portion gradually merges into the surrounding structures. Instead of an epithelial, it is then covered by an epidermal, layer.

The connection of these areas of exposed bone and the diseased state of the tympanic mucous membrane is explained by the fact that the labyrinthian wall, having no vessels itself, depends upon the overlying mucous membrane for its nutrition. A submucous infiltration will cut off the supply of nutrition from this source, and the vessels of the osseous structure being insufficient, a superficial necrosis of the underlying bone ensues. This sequestrum acts as a foreign body, as evidenced by the sprouting granulations. The area of necrosis is indicated by a small red spot, through which the pus exudes. Palpation with a probe will reveal the roughened and exposed bone. The position and relation of the parts do not favor a spontaneous elimination of the necrotic elements, and the acute process develops into a chronic state.

The long continuance of the disease is caused by the necrosis,

a continual discharge and the constant development of granulations being kept up. The discharge becoming disorganized, furthermore exerts a deleterious action on the remaining mucous membrane of the tympanum. The author considers the vast majority of these osseous complications due more to a necrotic than a carious process. If such were not the case, the labyrinth itself would necessarily become involved much more frequently. Other parts of the bony tympanum are not so prone to disturbances of nutrition; probably owing to the fact that their mucous membrane is less firmly adherent to the subjacent bone, and that an anastomotic circulation is more easily established. Caries is more apt to occur here than the above-mentioned process, and may also prove the active cause of a chronic suppuration. The author attributes the destruction of the soft structures and the underlying bone to the virulent action of the secreted pus. The floor of the tympanum rarely participates in this process; probably due to an inherent resistance of this part of the bone to the destructive action of the pus. The lower anterior portion of the labyrinthian wall, on the contrary, frequently reveals bow-shaped areas of exposed bone, and it is quite probable that the constant irritating action of the decomposed pus will exert a destructive influence upon the soft structures. These soon become disintegrated, and the bone is secondarily affected. These facts point to the necessity of a careful treatment of all acute inflammations of the tympanum, of an early paracentesis to prevent the pressure of the accumulated secretion upon the tympanic mucous membrane. The early evacuation of the pent-up pus will also obviate the irritating action of the products of decomposition, which may develop at any period as long as the tubes are patent.

25. EITELBERG has tested the efficacy of 0.1–0.2-per-cent. solutions of corrosive sublimate in the treatment of purulent middle-ear catarrh. Its use was beneficial in cases of diffuse external otitis subsequent upon purulent inflammation of the middle ear. It further appeared to assuage the pain in acute inflammation, and occasionally to exert a controlling effect on the otorrhœæ. In efficacy it ranks below boracic acid, nitrate of silver, and even iodoform. Eitelberg derived no appreciable benefit from the dry treatment in combination with plugs of iodoform gauze.

26. ARIZA treats exhaustively (54 pages) and most thoroughly of the symptoms, complications, and treatment of purulent affections of the middle ear.

27. NATHAN examined the pus of forty cases of otorrhœa placed at his disposal by Prof. Bezold. In twelve of these he found bacilli of tuberculosis. Amongst forty-six preparations these were demonstrable in forty. Other traces of pulmonary tuberculosis corroborated these results in eight of the twelve cases. Physical examination revealed no pulmonary affection in the ninth case, that of a scrofulous child. The remaining three were subjects to caries; one suffered from a sequestrum in the mastoid, and caries of the ossicles existed in the other two cases. The other twenty cases, in which an examination revealed no bacilli, embraced various diseases; in three there was disease of the adjacent cells, and perforation of Shrapnell's membrane. The presence of bacilli in the aural discharge of those patients also presenting pronounced pulmonary complications, places beyond doubt the phthisical nature of the middle-ear trouble. It further exerts a determining influence upon the prognosis of these cases.

28. NEVE publishes a case of acute inflammation of the middle-ear, extending to the mastoid process, occurring in a syphilitic patient. The case was observed in the Cashmere Mission Hospital. Paracentesis of the membrane proving ineffectual, the mastoid process was opened and rapid recovery ensued.

29. ZAUFAL opened the mastoid process in a young man aged twenty-four, suffering from thrombosis of a sinus, the result of a purulent middle-ear inflammation. After penetrating to a considerable depth, he came upon an accumulation of pus, and found partial destruction of the floor of the sulcus sigmoideus and of the wall of the sinus. The sinus was syringed with a two-percent. solution of carbolic acid. Fourteen days later the patient succumbed to an attack of pleuro-pneumonia. There were no traces of a purulent meningitis. An organized thrombus at the jugular foramen resisted the advance of the stream of water in syringing. In answer to the question, whether or not, under these circumstances, trepanation of the mastoid is justifiable, Zaufal is of the opinion, "that other cases should be treated similarly, to increase the number of instances on record, so as to decide relatively the chances of recovery by spontaneous cure or by surgical interference."

31. DÉJERINE communicated to the Société de Biologie a case of pressure of the chorda tympani with subsequent atrophy, due to an intra-tympanic collection of secretion. The patient, however, presented no disturbances of the sense of taste during the

course of the illness, and all the muscles innervated by the facial nerve retained their Faradic contractility.

32. HABERMANN has added another case of tenotomy of the stapedius to the instances previously recorded by Kessel and Urbantschitsch. The latter has performed this operation three times. The case described is that of a woman who suffered from low noises in the right ear simultaneously with spasms of the right eyelid. Even after the latter had disappeared, the mere closing of the eyelids was sufficient to provoke an attack of the tinnitus; vertigo and a gradual impairment of hearing accompanied the above symptom. The whispering voice was heard merely at the distance of one metre, while the ticking of a watch was only detected on contact. The author attributed the tinnitus to a clonic spasm of the stapedius muscle occurring simultaneously with a spasm of the orbicular muscle, both being innervated by the facial nerve. After ineffectual treatment by electricity, he decided to perform tenotomy of the stapedius. The absence of the posterior half of the membrane, and the distinct definition of the descending process of the incus, the posterior ramus of the stapes, and part of the tendon of the muscle itself, greatly facilitated the operation. The muscle was divided with a paracentesis needle without producing any pain. The patient at the time merely experienced a slight movement in the ear accompanied by a faint tinkling sound. The operation was immediately followed, even on firm closure of the lids, by a complete disappearance of the tinnitus and the vertigo. The watch was now heard at a distance of 0.02 metre, while there was no palpable variation in distance for whispering voice. Habermann does not refer to the two cases described by Moos in this journal, in which the latter attributes the symptoms induced by spasm of the stapedius to negative variations of intra-labyrinthian pressure.

33. The statistics are incomplete; but, so far as known, in the fifty cases there were only eight deaths. In one case the middle cerebral fossa was entered, causing death. In another the lateral sinus was opened, but the patient recovered.

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34. Though the treatment (by Dr. Sexton) is claimed to be "non-active," the course pursued was such as is usually followed—namely, removal of polypi and granulation and the keeping up of effective drainage. When the sequestrum became loose it was removed by the forceps.

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35. While recommending the method strongly where it is properly indicated, the author thinks it not useful in (1) very profuse discharges, (2) where polypi or granulations exist, (3) where there is caries or necrosis, (4) in mastoid disease, or (5) in suspected meningeal complications. He likes the combination of boracic acid and resorcin.

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36. The author answers this question in the affirmative. When an expert is not at command for complete examination of the organ of hearing, he suggests that the insurance examiner (1) cover the eyes and test each ear separately with the watch; (2) inspect in good daylight the entire auricular region, especially noting the condition of the mastoid or cicatrices thereabouts; (3) inspect (as gas-fitters do in proving their work) each auditory meatus.

SWAN M. BURNETT.

#### NERVOUS APPARATUS.

37. LORENZ ECKERT. Ménière's disease. Verlag von Beno Schwabe, Basel, 1884.

38. P. HERMET. Deafness in syphilitic tabes. *Union méd.*, No. 86, 1884.

39. VERMYNE. Myxo-fibroma at the basis cranii causing blindness, and seven years after, complete deafness, by destruction of the labyrinth. *Phila. Med. News*, July 26, 1884.

40. C. A. TODD. Necrosis of the right labyrinth; total facial paralysis on the same side; partial recovery. *Trans. Amer. Otol. Soc.*, 1884.

41. C. H. BURNETT. Reflex aural phenomena from nasopharyngeal catarrh; objective noises in and from the ear. *Trans. Amer. Otol. Soc.*, 1884.

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37. In this treatise ECKERT reviews in a comprehensive manner all hitherto published cases and articles pertaining to Ménière's disease. Based upon these and fifteen cases of Burckhardt-Merian, as yet unpublished, the author attempts to draw a distinct anatomical basis for the various symptoms of Ménière's disease, and arrives at the following conclusions:

1. The semicircular canals, with their ampullæ, are the organs of the sense of co-ordinate motion, directly for the head, indirectly for the entire body.

2. The localization of sound is determined by binaural power

of hearing. The semicircular canals take no part in this, but possibly exert acoustic functions in other respects.

3. The appearance of the various symptoms of Ménière's disease is in most cases attributable to a diseased state of the terminal apparatus of the acoustic nerve in the labyrinth. It is only in rare instances that these are called forth by pathological changes in the adjoining nerve centres.

4. Pathological changes or conditions in the middle ear and in surrounding structures, producing a change in the intra-labyrinthian pressure, may call forth a similar train of symptoms.

5. The symptoms are induced by an irritation of the labyrinthian organs or their nervous centres. Complete destruction of the same seldom calls forth a loss of function.

6. Disturbances of co-ordinate motion may be absent in pronounced chronic or acute affections of the labyrinth.

7. Constitutional diseases, such as lues, leukæmia, epidemic parotitis, and tabes, are recognized factors predisposing to the development of Ménière's disease.

A careful recapitulation of the literature on this subject closes the article.

38. HERMET reports several cases of almost sudden deafness affecting patients suffering from syphilitic locomotor ataxia. Deafness generally develops in the pre-ataxic stage ; occasionally it sets in when the disease is quite pronounced. This form of deafness is characterized by its rapid development and by the unaffected state of the middle ear. This condition is probably analogous to atrophy of the optic nerve in the same affection. If it develops at an early stage, other symptoms of tabes should be sought for. Similar aural troubles, due to inherited syphilis, develop between the age of fifteen and twenty.

39. VERMYNE reports the history of a patient who, in 1876, complained of slight visual impairment. Excepting a hyperæmic state of the papilla and the retina, nothing abnormal was found. Three months later, attacks of violent headache and neuritis optica led to the diagnosis of cerebral tumor. On examining the case five years later, Vermyne found atrophy of the optic nerve and complete loss of vision. Total deafness soon developed, and the patient died eight years after the onset of the disease. An autopsy revealed a tumor 6 *cm.* long, 4 *cm.* broad, and 2 *cm.* in thickness, occupying the inferior occipital fossa. The left cerebellar hemisphere was compressed to one third its normal size.

Both cerebrum and cerebellum were anæmic and the ventricles distended with fluid. That part of the tumor of most recent development encroached upon the petrous portion of the temporal bone, completely destroying the portion between the posterior part and the exposed tympanic cavity. The membrana tympani was intact. A microscopic examination showed the tumor to be myxo-fibromatous in character.

40. A discharge following measles since her fourth year. Left ear healed; right continued to discharge. When nineteen, granulations and a sequestrum of bone removed, which was found to be the cochlea. Paralysis of that side of the face, and loss of taste in the part supplied by chorda tympani nerve. Under electricity the facial muscles regained some of their power.

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41. The author thinks that objective noises in the ear may be due in some instances to reflex influences from the inflamed nose-pharynx. The irritation is, in this case, reflected to the muscular tissues of the velum palati, the fibres of the superior constrictor of the pharynx and the pterygoid muscles producing clonic spasms, which cause the snapping noises heard sometimes at quite a distance from the patient. Several cases are given in illustration.

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#### NOSE AND NASO-PHARYNX.

42. Dr. TH. HERING, of Warsaw. The use of chromic acid as a caustic in diseases of the nose, pharynx, and larynx. *Bulletin et mém. de la Société franç. d'Otol.*, tom. i., p. 149.

43. Dr. RAFAEL ARIZA. The influence of chronic coryza and follicular pharyngitis on the singing voice. Madrid, 1884.

44. Dr. VOLTOLINI, of Breslau. Epistaxis. *Revue mens. de laryngol. d'otol.*, etc., No. 11., 1884.

45. Dr. CZARDA. Foreign bodies and calcareous concretions in the nose. *Gaz. médic. de Paris*, No. 49, 1884.

46. Dr. SCHMIEGELOW. Remarks on rhinoliths. *Revue mens. de laryng. d'otol.*, etc., No. 11, 1884.

47. Dr. H. SCHMALTZ. Indications for the operative removal of Luschka's gland. Jahresbericht der Gesellschaft für Natur und Heilkunde in Dresden, 1884.

48. B. FRÄNKEL. Adenoid vegetations. *Deutsche med. Wochenschr.*, No. 41, ff., 1884.

49. DR. GUYE. Mouth-breathing from a hygienic standpoint. *Congrès intern. d'hygiène*, etc. Amsterdam, 1884.

50. J. A. WHITE. Naso-pharyngeal obstructions and hypertrophies in their relation to hearing. *Trans. Va. Med. Soc.*, 1884.

42. According to HERING, the apparent inconvenience attending its use, and the fear of toxic effects, have been the only drawbacks to a more extended use of chromic acid. As employed by the author however, its use is extremely convenient; he simply fuses a crystal upon the end of a heated silver probe and applies it as the case may require. The trifling pain attending its use is a point in its favor. Unpleasant after-results are prevented by cleansing the nares with a solution of soda. Hering has used it with best results in the treatment of adenoid vegetations, granulations, polypi, hypertrophies, etc. His experience leads him to consider it the most efficient medicinal agent at hand in the treatment of chronic nasal catarrh with thickening and hypertrophy of the turbinated bones.

43. ARIZA draws attention to the unfavorable influences which chronic nasal catarrh and follicular pharyngitis exert upon the singing voice. These conditions frequently lead to follicular laryngitis and reflex paralysis of the laryngeal muscles. Instructors should bestow greater attention to these troubles and induce pupils to adopt curative measures.

44. Following some anatomical introductory remarks, VOLTOLINI refers to a case of epistaxis, described in his treatise on "Rhinoscopy and Pharyngoscopy," in which the source of the hemorrhage was traced to a small excrescence situated between the middle and lower turbinated bones. Since then, he is also able to confirm the observations of others, that cases of habitual epistaxis generally originate from a small area of the cartilaginous septum. The author attributed one case of epistaxis, in which he could not trace the source, to diapedesis. The application of the galvano-cautery to the inferior turbinated bone soon checked the hemorrhage. Voltolini attributes habitual epistaxis to a personal predisposition and to the vascular state of the nares. The author treats all cases with the galvano-cautery. The patient should stay in-doors till all inflammation subsequent upon the application has subsided. Voltolini recommends anterior and posterior tamponing of the nose in violent hemorrhages. In tamponing the nasopharynx, the soft palate is drawn forward by the hook, and the cotton tampons are introduced with forceps having a retro-nasal



curve. In addition, the author extols his method of examination by direct sunlight, the use of his nasal speculum, his galvano-cautery, etc. The publications of Kisselbach and of the reviewer pertaining to this subject seem to have escaped his attention.

45. CZARDA reports five cases of foreign bodies in the nose. In the first case the nucleus consisted of a plug of cotton and a piece of cork weighing 7 grm.; the second instance was a mass of lime concretions surrounding the half of a plum-stone; the third, a pea swollen to triple its natural dimensions; and the fourth, a cork the size of a bean. The fifth case occurred in a man, aged thirty-two, who suffered nightly of violent itching in the nose, and who presented all symptoms of neurasthenia. Examination revealed the presence of a juniper berry which, after removal, weighed 25 grm. The size of the concretions on it points to the probability that its presence dated from early youth. Unilateral coryza was a constant feature in all the cases, and, according to the author, is characteristic of the presence of rhinoliths or other foreign bodies.

46. SCHMIEGELOW reports the case of a patient who had been subject for sixteen years to a purulent, fetid discharge from the left nostril, and who also suffered from total impermeability of the same side. On becoming flushed, a profuse unilateral sweating always affected the same side of the head. This symptom disappeared four years prior to the period of examination. Inspection revealed the presence of a rhinolith, which, after being crushed with a pair of strong forceps, was removed by syringing. The concretion contained no nucleus, was laminated in structure, and enclosed but little organic matter. Schmiegelow considers a fetid, purulent discharge existing for years, in combination with total occlusion of the nostril, always significant of the presence of rhinoliths.

47. SCHMALTZ dwells upon the frequency of hypertrophy of Luschka's gland. In diagnosis, he avails himself of posterior rhinoscopy without the use of the palate-hook. He operates with Hartmann's wire snare, modified by him to be used with the galvano-cautery. The more pronounced the symptoms, especially impediment to free nasal respiration, the earlier he operates. Aural complications favor early interference of the disease. The operation itself is rarely followed by any inflammatory reaction, and relapses never occur. The removal of only small portions is in itself sufficient to produce surprisingly favorable results.

48. B. FRÄNKEL treats of adenoid vegetations in the naso-

pharynx in a "text-book" style, similar to the publications of Meyer, Löwenberg, and others. The nature, origin, appearances, examinations, symptoms, and treatment of this disease are dwelt upon in a most thorough and exhaustive manner.

49. Referring to the well-known expression of Catlin, "Shut your mouth and save your life," GUYE expatiates upon the causes and vicious results attending mouth-breathing. He treats this faulty habit by the use of a contra-respirator. This respirator, which he described ten years ago, differs from others of the same class in having an impermeable plate, and compelling the wearer to breathe through the nostrils.

50. W. considers the dust from macadamized streets a prolific cause of naso-pharyngeal irritation. His experience substantiates the belief that vegetations in the upper pharynx frequently cause deafness. In all cases of mouth-breathing, and in all cases of obstruction in the lower nasal meatus, there will ultimately be impaired hearing. The author then goes on to consider the various forms of nasal and pharyngeal obstruction. He considers chromic acid one of the best chemical cauteries. When the hypertrophy of the tonsils is dense, he extirpates.

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## MISCELLANEOUS NOTES.

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Baron LÉON DE LENVAL, at Nice, France, has founded a *prize of frs. 3,000, as a premium for the best hearing trumpet constructed after the principle of the microphone*. Instruments competing for the prize are to be sent before Dec. 31, 1887 to one of the members of the jury, Prof. E. Hazenbach-Bischoff, M.D., Basel ; Dr. Benni, Warschaw ; Prof. Burckhardt-Merian, Basel ; Dr. Gellé, Paris ; Prof. A. Politzer, Vienna.

In awarding the prize particular attention will be paid to the perfection of the mechanical construction of the instruments, the correct application of physical laws, and above all, its efficiency as an aid to persons hard of hearing. The decree of the jury will be published at the Fourth International Otological Congress at Brussels, Sept., 1888.

We welcome a new edition—the third—of W. B. DALBY's very excellent **Lectures on Diseases and Injuries of the Ear**, 260 pp. Churchill, 1885.

The chief new matter in this edition relates to tests of hearing, the position now occupied by operations on the tympanic membrane and one new lecture on adenoid growths and enlarged tonsils.



Fig. I.



Fig. IV a.



Fig. IV b.

Fig. II.

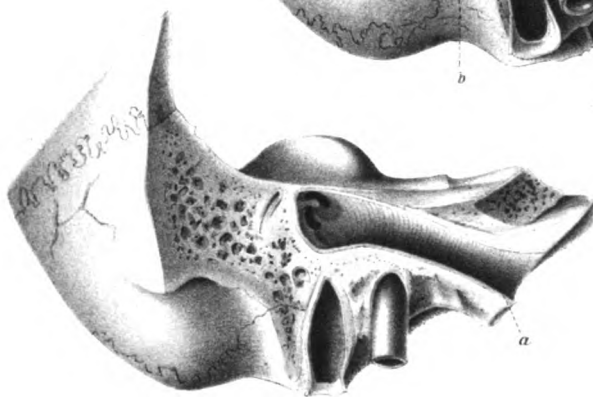
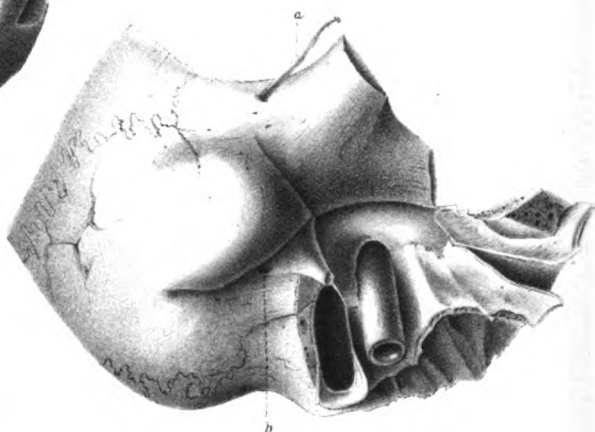
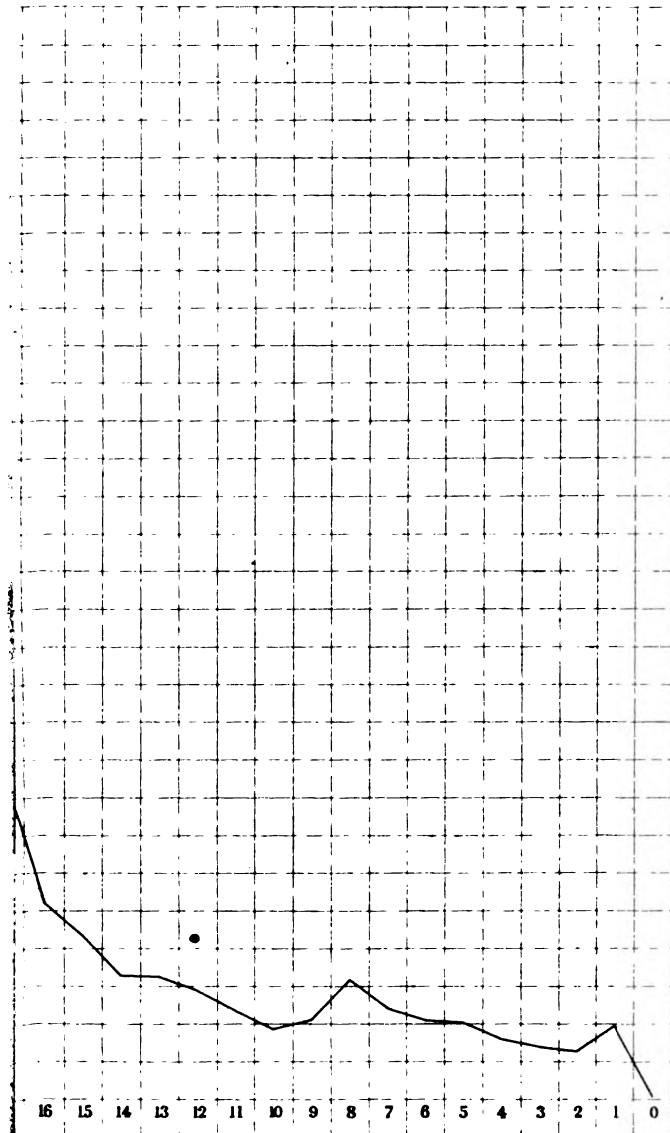


Fig. III.



Tab. II.

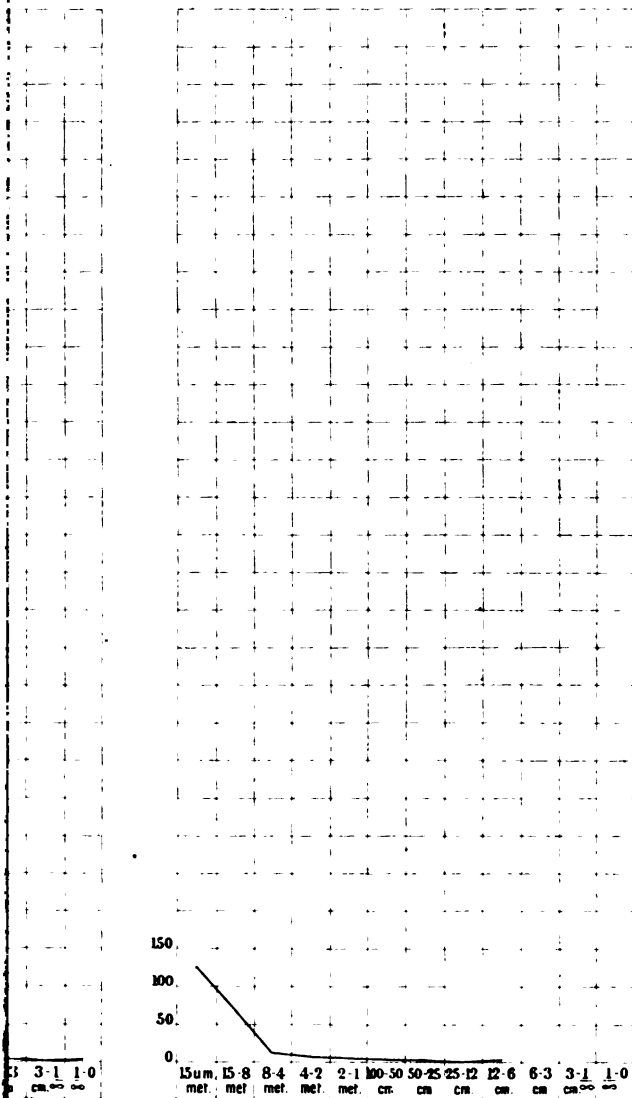
Anteil der 3836 untersuchten Gehörorgane für Flüstersprache  
nach Metern eingeteilt. (Tabelle III.)





e VIII.)

# Holland'sches Institut mit 222 Gehörorganen. (Tabelle VI.)







## ARCHIVES OF OTOTOLOGY.

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### FRACTURE OF A SMALL PORTION OF THE TYMPANIC PLATE OF THE TEMPORAL BONE FROM EFFORTS TO REMOVE A PIN SUPPOSED TO BE IN THE EAR.

By THOMAS BARR, M.D.,

SURGEON TO GLASGOW HOSPITAL FOR DISEASES OF THE EAR; LECTURER ON AURAL SURGERY,  
ANDERSON'S COLLEGE, GLASGOW, ETC., ETC.

A woman, aged about fifty years, evidently of a nervous disposition, was brought to me on the 18th June last for the purpose of having a pin, which was supposed to be imbedded in the walls of the left internal auditory canal, removed. In order to allay itchiness in the ear she had been in the habit of scratching the external meatus with a pin, and her story was that, four weeks previously, she awoke at four o'clock in the morning just at the moment that a pin, with which she had been picking her ear while half asleep, had slipped into the passage of the ear. She was excessively alarmed, and the family doctor was at once sent for, who made efforts, by means of forceps, to remove the pin from the ear, but ineffectually. In the evening of the same day these efforts were renewed with greater determination and perseverance, so that for an hour and a half (according to the statement of the patient and her husband) *something* was pulled at with strong forceps by the doctor, whose arm was helped by the husband, so as to make the traction more powerful. At length a snap was heard, supposed to be due to the breaking of the pin into two parts. No fragment of a pin, however, was ever seen to come out. The ear now bled freely, poultices were ordered, and she was told that the pin would suppurate out. The poultices were continued night and day till her visit to me. During these four weeks she suffered greatly, partly from pain, but chiefly from anxiety due to her firm belief that a pin was in the interior of her ear, and might lead at any moment to the most disastrous consequences. Indeed, she asserted that since the occurrence sleep had almost entirely left her.

On examination, there was purulent secretion in the orifice of the ear, and, on removing this, a polypoid growth was seen to fill the lumen of the canal not far from the outer orifice, and having its base in the antero-inferior part of the canal. The growth was removed with the snare close to its root, which was found by means of a probe to cover an orifice in the soft parts leading to a hard, rough, slightly movable substance, just in the situation of the outer rough edge of the tympanic plate. No trace of a pin, or of any part of one could be found in the whole of the external auditory canal, which was seen in every part. In the antero-superior quadrant of the tympanic membrane, however, a small perforation existed, from which some muco-purulent secretion escaped from the tympanic cavity. The hearing power was very defective : Watch,  $\frac{5}{16}$  ; increased to  $\frac{1}{4}$  after Politzerization. Tuning-fork applied to middle line of head was heard more loudly in this ear.

On the first examination it was impossible to decide whether the rough, hard substance felt with the probe was bone or a metallic substance. But on examining again with the probe, on the following day, the sensation seemed to favor the view that it was bone, and not a metallic substance, a view which was confirmed a few days afterwards when I withdrew with forceps from the wound in the canal two small pieces of semi-dead bone, evidently from the edge of the tympanic plate. It was difficult for a time to persuade the woman that no pin existed in her ear. "I can feel it," she said, and it seemed that during these weeks she frequently touched the bone with the blunt end of a darning-needle, and naturally believed that this was the lost pin. After the pieces of bone came away I still felt for a few days the firm bare edge of the tympanic plate, but the wound gradually healed, and in about two weeks from the time of the removal of the bone it had entirely healed. Before that time had elapsed the perforation in the tympanic membrane had cicatrized under treatment by cleansing, drying, and inflation. Simultaneously the hearing power markedly improved. I heard from her on the 3d of Sept., and then she felt the ear to be quite well.

This is another of many instances which have been recorded of the evil consequences which may ensue from attempting, by means of instruments, to remove a foreign body from the ear before it has been ascertained, through

inspection of the whole of the external auditory canal, that a foreign body is really present. In this case, what occurred was probably the following : The pin either did not pass into the canal of the ear at all, or, if it did, must have slipped out soon after, unknown to the patient. The doctor, taking the woman's view for granted, assumed that the pin was in her ear. In his attempt to lay hold of something, the antero-inferior angle of the canal, at the junction of the cartilaginous and osseous portions, was probably grasped, and an aperture made by the forceps in the skin and membrane connecting the cartilage with the tympanic plate. The rough edge of the tympanic plate would then be readily seized with the points of the forceps, conveying to the operator the idea that some part of a pin, firmly imbedded somewhere, was being grasped, and so justifying to him the strong efforts of traction being continued. If the tympanic plate of a dried temporal bone be examined, it will be seen how readily this part of the bone would be laid hold of, and how it might be pulled at for a long time without effect. The snapping sound heard at last was probably due to the breaking of a portion of the edge of the bone, the broken portions being those which came away four weeks afterwards. The subsequent inflammation, aided by the constant poulticing, accounted for the suppuration, polypus, and perforation in the tympanic membrane.

# EXAMINATIONS OF THE AUDITORY ORGAN OF SCHOOL-CHILDREN.\*

BY DR. FRIEDRICH BEZOLD, MUNICH.

Translated by ISIDOR FURST, New York.

(With four plates of curves and three wood-cuts.)

## RESULTS OF THE EXAMINATION OF THE EXTER- NAL AUDITORY CANAL AND THE DRUM MEMBRANE.

### ACCUMULATIONS OF CERUMEN.<sup>1</sup>

#### *a.—Hindering Examination and Partly Occluding the Lumen.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	79	60	18	10	167	7.1	8.4	6.1	4.2	7.2
Protestant school.	73	67	15	13	168	13.4	14.2	8.5	14.6	13.1
Holland's Institute	(10)		(3)		(13)	(5.2)		(10.0)		(5.9)
Boys . . . . .	73	58	12	11	154	9.0	11.4	6.0	8.5	9.4
Girls . . . . .	79	69	21	12	181	9.3	10.1	7.7	7.2	9.2
Boys and girls . .	152	127	33	23	335	9.16	10.68	7.02	7.77	9.27

\* Concluded from page 209.

<sup>1</sup> I have here recorded all those accumulations which obstructed the view of a part of the drum membrane, especially the region of the short process or the light spot, but allowed a portion of the drumhead to be inspected. The slightly larger figures in the Protestant school are probably due to the fact that they were more accurately recorded. But as there were found in this school nearly double the number of *occluding* plugs present in the common school, we might suspect some connection with the season. The common school was examined in summer, the Protestant school in winter.

Here we find on comparing the four columns, aside from Holland's Institute where the number examined was too small, that there is no increase in the percentages among persons with defective hearing, but rather on an average a slight decrease. A slight increment, and that in all the series, is shown only in the second column of those hearing at 16-8 metres; and possibly we may conclude therefrom that when conjoined with other slight disturbances present, non-occluding accumulations may contribute in some degree to impair the hearing. That alone they are unable to cause impairment is shown by the results of apparently occluding accumulations.

*b.—Accumulations Apparently Occluding the Entire Lumen.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	8	17	7	14	46	0.7	2.4	2.4	6.8	2.0
Protestant school .	9	12	9	18	48	1.7	2.5	5.1	20.2	3.8
Holland's Institute	(2)		(2)		(4)	(1.0)		(6.7)		(1.8)
Boys . . . . .	5	15	2	21	43	0.6	2.9	1.0	16.2	2.6
Girls . . . . .	12	14	14	11	51	1.4	2.1	5.2	6.6	2.6
Boys and girls . .	17	29	16	32	94	1.02	2.44	3.40	10.81	2.61

The results of the first column should be first emphasized: 17 auditory organs, the inspection of which showed a plug apparently completely occluding the osseous meatus, heard whispered speech above 16 metres and hence had to be considered normal in their function. It is very probable that in all these cases a narrow chink was present between the accumulation and the wall, though it escaped observation; but they prove how small a lumen suffices for normal hearing, and on the other hand, in connection with the result of non-occluding accumulations, how unimportant is the shape of the ear canal in reference to the function of the ear.

The percentages increase pretty regularly with greater hardness of hearing, and they do so both in the total number and in the several schools and sexes, with the exception of a single number among the boys; they rise rapidly in the last column of those hearing at from 4-0 metres to 10.81 per cent., while we find among the normal hearing only 1.02 per cent., and among all the pupils, including those with impaired hearing, 2.61 per cent. This gives us an instance how a symptom which undoubtedly is connected with hardness of hearing finds expression in our tables, and in what way we have to expect this prominence in the percentages also with the other symptoms which are of more or less importance for the diagnosis.

#### NORMAL DRUMHEAD REFLEXES.

##### *a.—Triangular Reflex or Point in or near the Umbo.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	968	584	196	83	1831	86.9	81.3	66.9	40.1	78.5
Protestant school .	466	360	128	30	984	85.5	76.4	72.3	33.7	76.8
Holland's Institute	(185)		(19)		(204)	(96.4)		(63.3)		(91.9)
Boys . . . . .	699	388	133	48	1268	86.5	76.2	66.8	36.9	77.0
Girls . . . . .	735	556	191	65	1547	85.2	81.8	70.5	39.2	78.6
Boys and girls . .	1434	944	324	113	2815	86.44	79.39	68.94	38.18	77.89

In my original notes I have stated everywhere whether the normal reflex appeared triangular, sharp or diffuse, interrupted transversely or longitudinally, or as a simple diffuse spot or point in the umbo. However, all these various forms of the normal reflex are so irrelevant for the function, as I was able to convince myself, that I have abstained from complicating the tables by their special enumeration. All these different forms are summarized under *a*. One characteristic, however, the reflex had to

possess in order to be called normal: its point, even if diffuse, had to reach the umbo entirely or nearly; in other words, the funnel shape of the drumhead had to be present in its purity, or somewhat flattened at the point by the widening of the end of the manubrium mallei.

If we make the limits of the normal reflex thus broad, it is found among no less than 84.44 per cent. of all persons with normal hearing. Among those having successively worse hearing we demonstrate a regular decrease in its frequency, which is uniformly repeated in every single series of numbers of the above collection. These numerical relations must not be considered as a clear expression of the influence of form alterations of the drumhead on the function, —for the numbers among the persons with defective hearing are, of course, depressed besides by the greater number of occluding plugs of cerumen, of otorrhœas, and of perforations in the region of the reflex, which likewise fall in the column of defective hearing—but still this does not fully explain the great sinking of the numbers among the latter, and not a small part of the cases of absent reflex at the normal place is due to alterations of form of the drumhead in general or in the region of the normal reflex. We shall obtain a more exact expression than in the above tabulation among the divisions “absence of the normal reflex,” “displaced normal reflex,” “atrophy,” and “cicatrix.”

*b.—The Region of the Sulcus Reflex Covered by the Anterior Lower Wall of the Ear Canal.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above. 16. Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above. 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	402	251	106	49	808	36.1	35.0	36.2	23.7	34.6
Protestant school .	135	114	39	11	299	24.8	24.2	22.0	12.4	23.3
Holland's Institute	(140)		(17)		(157)	(72.9)		(56.7)		(70.7)
Boys . . . . .	237	134	55	17	443	28.1	26.3	27.6	13.1	26.9
Girls . . . . .	300	231	90	43	664	35.3	34.0	33.2	25.9	33.7
Boys and girls . .	537	365	145	60	1107	32.37	30.70	30.85	20.27	30.63



It was some special reason which caused me to devote more particular attention to this reflex streak at the anterior lower periphery among the other above-enumerated normal reflexes of the drumhead. The punctiform reflex on the short process, and the stripe-like or punctiform reflex at the anterior upper border of Shrapnell's membrane, were also noted wherever they were present ; but as no further interest attaches to the frequency of their occurrence, I have abstained from giving a *résumé* of them in the tables.

The sulcus reflex arises in the above-described manner as a linear streak encompassing the anterior lower periphery of the drumhead. As it is produced in the curve formed by the periphery of the drumhead with the external lip of the sulcus, we may be assured, when it is completely visible, that the drumhead can be inspected by us in its entire extent, provided no pathological anomalies of form, such as exostoses in the auditory canal or accumulations, prevent us otherwise. For the anterior lower periphery of the drumhead is the only place which is frequently hidden by a more curved course of the osseous canal and a corresponding projection of the lower anterior wall of the auditory canal. If we are able to inspect this portion likewise, the drumhead in its entire extent lies before us, and I have thought it not to be without interest to ascertain how often this is really the case. The number of auditory canals in which we can make the sulcus reflex visible is, as appeared in the course of these examinations, greater than that in which it is more or less completely invisible. Therefore, subsequently the latter only were counted, among which are included all those cases in which this reflex was wholly or largely covered by the anterior lower wall of the auditory canal ; other hindrances to the inspection of this region were left out of consideration.

It is not quite easy, in all the cases where there is still some possibility of seeing the reflex, to bring it to view. This is proved by the different figures I have obtained in the three schools, and which are to be explained evidently by some defect in my early technique. In Holland's Institute, which I examined first, I could not bring it to view in

70.7 per cent.; in the common school, which was next in order, in 36.6 per cent.; and in the Protestant school, examined last, only in 23.3 per cent. In order to see it as frequently as the anatomical relations will permit, the auditory canal must be energetically straightened both by traction on the auricle and by co-operative pressure against the posterior wall with the speculum, and the line of sight must run through the ear canal from behind above to in front below. Where the canal is wide and nearly straight, it can indeed often be inspected without the aid of a speculum. Rarely only is a reflex streak entirely absent at this spot, although the periphery is accessible to our eye. Hence by its frequency alone it deserves the title of a normal reflex, and we learn from this tabulation *that the anatomical relations, at least in children, in more than two thirds of the cases permit us to inspect the drumhead directly in its entire extent.*

The sulcus reflex suffers a pathological alteration only in so far as it may appear somewhat widened in depressions which implicate the anterior lower periphery of the drumhead. Even in other intense alterations of the drumhead, older perforations, etc., its presence may still be demonstrated; for this reason, in the above tabulation, we find a slighter decrease in its frequency in defective hearing than can be demonstrated with the triangular reflex.

We now come to the—

#### PATHOLOGICAL STATE OF THE DRUMHEAD REFLEXES.

##### *a.—Absence of the Normal Reflex.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . .	20	37	20	21	98	1.8	5.2	6.8	10.1	4.2
Protestant school . . . .	15	20	8	6	49	2.8	4.2	4.5	6.7	3.8
Holland's Institute . . . .	(—)	(—)	(3)	(—)	(3)	(—)	(—)	(10.0)	(—)	(1.4)
Boys . . . . .	27	33	18	14	92	3.3	6.5	9.0	10.8	5.6
Girls . . . . .	8	24	10	13	55	0.9	3.5	3.7	7.8	2.8
Boys and girls . . . . .	35	57	28	27	147	2.11	4.79	5.96	9.12	4.07

Into the tables were entered only those cases in which, excepting the sulcus reflex just discussed, there was no reflex present over the whole extent of the lower anterior quadrant of the drumhead, and in which the surface as a whole had not lost its lustre by maceration of the epidermis in consequence of inflammatory processes or secretion. Frequently in these cases the reflecting power of the external surface of the drumhead was positively proved by the presence of other reflexes, especially of the sulcus reflex or that on the short process and its surroundings. Auditory canals in which the free inspection of the anterior lower quadrant was interfered with were, of course, left out of consideration in the above tabulation.

As the region of the normal triangular reflex is the only one which is struck vertically by sound-waves impinging directly, we may assume that it receives the strongest impulses from these; and I think, therefore, that I can claim the presence of the normal reflex in the umbo as a postulate for a completely normal function of the sound-conducting apparatus<sup>1</sup>; Trautmann,<sup>2</sup> too, on the strength of two hundred examinations of the drumhead of children and soldiers, thinks "the function to be always reduced with alterations of the light reflexes due to anomalies of the curvature." I have shown above, on the figure of the drumhead section, in what manner a slight concave depression of the membrane as a whole may cause a complete disappearance of the normal reflex. The tabulation here given shows us that a complete absence of the triangular reflex is found not only with reduced function, but also with 2.11 per cent. of persons with normal hearing. Therefore, when this slight alteration of form of the drumhead, alone without other accompanying pathological alterations, especially without permanent occlusion of the tubes, influences the hearing distance at all, its reduction is so slight that it is altogether impossible to demonstrate it with our usual methods of examination.

If we consider the frequency of its absence among per-

<sup>1</sup> "Die Corrosionsanatomie des Ohres." Munich (Theodor Riedel), 1882, p. 24.

<sup>2</sup> Die Lichtreflexe des Trommelfelles. *Arch. f. Ohrenheilk.*, Bd. x., p. 91.

sons with defective hearing, we find both in the several schools and in the two sexes a regular increase with rising impairment of function, so that among those having the greatest hardness of hearing it is absent on the average four times as often as among the normal hearing. Symptomatically, therefore, the absence of the normal reflex cannot be called worthless.

*b.—Normal Reflex Far Removed from the Umbo toward the Periphery.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	22	26	34	36	118	2.0	3.6	11.6	17.4	5.1
Protestant school . . . . .	10	22	15	15	62	1.8	4.7	8.5	16.9	4.8
Holland's Institute . . . . .	(1)		(6)	(7)		(0.5)		(20.0)		(3.2)
Boys . . . . .	18	17	20	15	70	2.2	3.3	10.1	11.5	4.3
Girls . . . . .	14	31	29	36	110	1.6	4.6	10.7	21.1	5.6
Boys and girls . . . . .	32	48	49	51	180	1.93	4.04	10.43	17.23	4.98

Under this head were enumerated all those cases in which the normal triangular reflex had lost its point and appeared changed into a simple or divided, roundish, square, or irregular spot, whose position corresponded to the basis of the normal reflex, or usually was still farther removed toward the lower anterior periphery. In many cases this spot shows a remarkably bright lustre. That it should be accorded a separate position beside the other reflexes occurring in the anterior lower quadrant is evident by the fact alone that not rarely it can be observed simultaneously by the side of the latter. For instance, sometimes we can inspect all the three reflexes here under consideration at the same time on one drumhead: distant about the length of the absent triangular reflex from the umbo lies our roundish glossy reflex; still farther toward the periphery lies the glossy streak, which is due to the fact that the peripheral zone of the drumhead takes part but little, if at all, in the depression, and which Politzer explains as a phe-

nomenon of flexion, figured in his text-book<sup>1</sup>; and quite at the periphery we find, third, the above-described sulcus reflex. In these cases the three reflexes lie in such a way that they are cut in half by the line which divides the triangular reflex in two. The origin of the displaced normal reflex has been traced above to the formation of a greater pan-like depression of the drumhead, and it has been shown on the section of the drumhead that it must be considered as a true picture of a concave mirror.

Like the absence of the normal reflex, the occurrence of this alteration may be observed where the hearing distance is perfectly normal, although relative to its frequency generally it is somewhat rarer (in 1.93 per cent.).

If we trace its frequency in the successive degrees of hardness of hearing, we find throughout a uniform and much greater increase in it than in the simple absence of the normal reflex, so that it occurs on an average among those hearing at 4-0 metres in not less than 17.23 per cent., or nearly nine times as frequently as among the normal hearing. In accordance therewith is the pathognomonic value of this alteration of the reflex; in the frequency of its occurrence, as well as in its rapidly rising presence in the higher degrees of hardness of hearing, it follows directly on the "posterior fold," undoubtedly the most frequent symptom of depression.

It should be emphasized as a remarkable fact, that it is to be observed more frequently among the girls, both absolutely, and especially in the last column, containing the worst hearing; in the latter nearly twice as frequently as among the boys, although we shall see further on, in Table XXI., that the boys, on the whole, exhibit larger percentages of tubal affections than the girls.

Under *c* were included all those cases in which a reflex was present on Shrapnell's membrane which indicated concavity of the latter. It has been stated above that a stripe-like or punctiform reflex at its anterior and upper border, if present, is to be considered normal. Reflexes of *convexity* are to be rarely observed spontaneously in this region, and

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<sup>1</sup> Bd. i., p. 306.

in that case it is not difficult to distinguish them from the reflexes of concavity, mostly by the simultaneous presence of the sickle-shaped reflex of convexity at the posterior upper periphery.

Under *d* were included all reflexes *behind* the short process, from a simple point or glossy streak on the posterior fold to the uniform lustre of the entire portion of the drumhead lying above this fold, of course excluding the occasional reflexes of convexity occurring shortly after blowing the nose.

*c.—Macular Reflex ABOVE the Short Process.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	8	8	4	3	23	0.7	1.1	1.4	1.4	1.0
Protestant school . . . . .	3	4	1	2	10	0.6	0.8	0.6	2.2	0.8
Holland's Institute . . . . .	(6)		(—)		(6)	(3.1)		(—)		(2.7)
Boys . . . . .	7	8	2	2	19	0.9	1.6	1.0	1.5	1.1
Girls . . . . .	4	4	3	3	14	0.5	0.6	1.1	1.8	0.7
Boys and girls . . . . .	11	12	5	5	33	0.66	1.01	1.06	1.69	0.91

*d.—Punctiform, Linear, or More Expanded Reflex BEHIND the Short Process.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	18	26	17	12	73	1.6	3.6	5.8	5.8	3.1
Protestant school . . . . .	15	22	7	7	51	2.8	4.7	4.0	7.8	4.0
Holland's Institute . . . . .	(4)		(1)		(5)	(2.1)		(3.3)		(2.3)
Boys . . . . .	11	24	11	9	55	1.4	4.7	5.5	6.9	3.3
Girls . . . . .	22	24	13	10	69	2.6	3.5	4.8	6.0	3.5
Boys and girls . . . . .	33	48	24	19	124	1.99	4.04	5.11	6.42	3.43

It appears from the above tables that although the forms *c* and *d* are to be considered pathological, inasmuch as their frequency grows almost throughout with increasing hardness of hearing, they have been met with on the one hand more rarely generally, especially the macular reflex above the short process, and on the other hand they do not increase in progression as they approach the zero point of the hearing distance, as we have seen to be the case with the normal reflex displaced towards the periphery.

A part, though small, of the reflexes of concavity in Shrapnell's membrane is to be traced, as I have learned from the clinical history of several cases, to a former perforation at this place and its closure by a cicatrix.

All these reflexes, like the displaced normal reflex, come under observation also with normal hearing distance; that *above* the short process in 0.66 per cent., and that *behind* the latter in 1.99 per cent. among those with normal hearing.

#### COLOR ANOMALIES OF THE DRUMHEAD.

Acute and subacute inflammatory alterations on the drumhead, which were entered under two heads, (*a*) *diffuse reddening and extravasation of blood*, (*b*) *serum perceptible in the drum cavity*, were but rarely present; injection and extravasation of blood on the whole in 0.42 per cent., and perceptible serum in 0.21 per cent.

Neither alteration causes necessarily a reduction of the hearing distance, which, despite their presence, in some cases amounts to over 16 metres for whispered speech. Although the common school was examined in summer, and the Protestant school in winter, the figures of both in these columns offer but slight differences. Their special tabulation can be of little use to us here on account of the small numbers.

The records of "diffuse opacities," comprising the cases in which the opacity was spread more or less uniformly over the drumhead, are to some extent arbitrary, because the limit between normal and pathological admixture of white to the color of the drumhead cannot be sharply drawn, and also because the varying illumination can easily lead to

deception in the estimation. In the table only the more pronounced opacities were taken note of. That they should not be passed over appears from the fact alone that of the alterations enumerated under from *a* to *d* they give relatively the most certain landmark of the presence of a disturbance of function, as becomes evident from an inspection of the four tables.

PATHOLOGICAL OPACITIES AND DEPOSITIONS IN THE SUBSTANCE OF THE DRUMHEAD.

*a.—Diffuse Opacities.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	15	14	14	12	55	1.3	2.0	4.8	5.8	2.4
Protestant school .	4	13	6	—	23	0.8	2.8	3.4	—	1.8
Holland's Institute	(8)		(5)		(13)	(4.2)		(16.7)		(5.9)
Boys . . . . .	10	12	10	2	34	1.2	2.4	5.0	1.5	2.1
Girls . . . . .	9	15	10	10	44	1.0	2.2	3.7	6.0	2.2
Boys and girls . .	19	27	20	12	78	1.15	2.27	4.26	4.05	2.10

*b.—Circumscribed Opacities.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	114	104	49	20	287	10.2	14.5	16.7	9.7	12.4
Protestant school .	59	68	30	13	170	10.8	14.4	16.9	14.6	13.3
Holland's Institute	(29)		(3)		(32)	(15.1)		(10.0)		(14.5)
Boys . . . . .	80	65	30	15	190	9.9	12.8	15.1	11.5	11.5
Girls . . . . .	93	107	49	18	267	10.9	15.7	18.1	10.8	13.6
Boys and girls . .	173	172	79	33	457	10.43	14.47	16.81	11.15	12.65



*c.—Calcifications.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public school . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	14	6	8	7	35	1.3	0.8	2.7	3.4	1.5
Protestant school .	8	6	3	3	20	1.5	1.3	1.7	3.4	1.6
Holland's Institute	(2)		(—)		(2)	(1.0)		(—)		(0.9)
Boys . . . . .	9	3	6	4	22	1.1	0.6	3.0	3.1	1.3
Girls . . . . .	13	9	5	6	33	1.5	1.3	1.8	3.6	1.7
Boys and girls . .	22	12	11	10	55	1.33	1.01	2.34	3.38	1.52

*d.—Posterior Streak of Opacity.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	56	42	21	11	130	5.0	5.9	7.2	5.3	5.6
Protestant school .	6	12	9	3	30	1.1	2.5	5.1	3.4	2.3
Holland's Institute	(8)		(3)		(1)	(4.2)		(10.0)		(5.0)
Boys . . . . .	48	28	14	5	95	5.9	5.5	7.0	3.8	5.8
Girls . . . . .	14	26	16	9	65	1.6	3.8	5.9	5.4	3.3
Boys and girls . .	62	54	30	14	160	3.74	4.54	6.38	4.73	4.43

Diffuse opacity of the entire drumhead likewise comes under observation in a number of persons with normal hearing (1.15 per cent). Its frequency rises pretty regularly with increase in the hardness of hearing in the various schools and sexes, but decreases again, in early age, on an average among the highest degrees of reduction of function.

There are special points or predilection for the "circumscribed opacities," for instance, the whole or a part of the intermediary of the peripheral zone; the latter is mostly affected in the anterior lower quadrant. Relatively fre-

quently, the anterior upper quadrant likewise shows a whitish opacity over a greater extent or only in its upper angle. Dendritic opacities, which possibly owe their origin in part to the dendritic fibrous structure described by Gruber, are more frequently found in the posterior half. All these various forms of opacity and thickening of the substance of the drumhead have been grouped together under the common head of "circumscribed opacities."

They could be demonstrated with great frequency, altogether in 12.65 per cent., although slight indications were disregarded. How little their presence *per se* disturbs the auditory function appears from the fact that they exist in not less than 10.43 per cent. of the normal hearing. In the slighter degrees of hardness of hearing we observe a moderate increase in their frequency which, however, proves much smaller than in the case of the diffuse opacities. The highest grades again show a diminished number, as do the diffuse opacities.

Of "calcifications," which were most frequently found in the posterior or anterior intermediary zone, at times by the side of still persisting perforations or cicatrices of the drumhead, it has been repeatedly shown in the literature that their presence does not necessarily form a hindrance to the normal function; they exist in our examinations in 1.33 per cent. of the normal hearing. As opposed to the simple diffuse and circumscribed opacities, their frequency grows most considerably among the highest degrees of hardness of hearing—a fact which perhaps should be explained by their frequent connection with former purulent processes.

Finally a separate entry was made of the "posterior streak of opacity," because in at least a part of the cases it is distinguished from the other opacities by its mode of origin. By this short term I understand the streak of opacity which frequently extends from the short process backwards and downwards, beginning as a more or less sharp line and either (1) ending at the posterior border of the drumhead; or (2) gradually disappearing farther downward in the posterior half; or (3) merging in a further zonular opacity. It is probable, at least in conditions 1 and 2, that it has de-

veloped at the place of a former posterior fold, and thus points to preceding tubal processes, all the more because we often enough find streaks of opacity and the formation of folds at one and the same time. However, not always is the long existing flexion at this point to be considered as the most probable cause of the posterior streak of opacity. Not rarely we see the streak merely as the clearly-marked commencement of an opacity which occupies the entire intermediary or the whole or a part of the peripheral zone. In these cases it is possible that inflammatory processes, which were localized exclusively in the membrana tympani and the drum cavity, may have led to deposits at this point in particular, because by its greatest tension it gives rise with special facility to disturbances of circulation. Opacity of the whole intermediary zone, too, which is of frequent occurrence, may possibly be traceable in a part of the cases to a persistent flexion due to greater depression of the central funnel of the drumhead.

We encounter the posterior streak of opacity likewise with comparative frequency (in 3.74 per cent.) in normal relations of hearing. We meet it somewhat more frequently in hardness of hearing of various grades, but the frequency decreases again in the highest degrees. This latter circumstance, which we have seen to recur in all the various forms of opacity with the exception of calcification, might be interpreted thus: That by themselves, even if extensive and thickly deposited in the substance of the drumhead, they cause only a moderate degree of hardness of hearing, or occur, as a rule, at least in juvenile age, merely by the side of the slighter similar pathological alterations in the sound-conducting apparatus. Possibly, in view of the slight rise of the figures which is presented by all the opacities, this small decrease of the frequency in high degrees of hardness of hearing finds a simpler explanation in the fact that this column includes also most cases of occluding plugs and otorrhœas which rendered inspection of the drumhead impossible, and, of course, enlarge the total of this column in proportion to the numbers here to be considered.

As to the pathognostic significance of the various forms of

opacity in general, the numbers found show that they possess on the whole but a slight diagnostic value. The last place in this respect is occupied by the frequent circumscribed opacities; some greater weight attaches to the posterior streak of opacity, to diffuse opacity of the entire drumhead, and, especially for the higher degrees of hardness of hearing, to calcifications.

FORM ANOMALIES OF THE DRUMHEAD.

*a.—Posterior Fold.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	50	58	48	50	206	4.5	8.1	16.4	24.2	8.8
Protestant school . . . . .	10	23	19	11	63	1.8	4.9	10.7	12.4	4.9
Holland's Institute . . . . .	(14)		(9)		(23)	(7.3)		(30.0)		(10.4)
Boys . . . . .	37	49	33	30	149	4.6	9.6	16.5	23.1	9.1
Girls . . . . .	23	32	34	31	120	2.7	4.7	12.5	18.7	6.1
Boys and girls . . . . .	60	81	67	61	269	3.62	6.81	14.26	20.61	7.42

*b.—Manubrium Mallei Widened or Short Process Projecting.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-10 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	9	17	12	7	45	0.8	2.4	4.1	3.4	1.9
Protestant school . . . . .	6	15	8	8	37	1.1	3.2	4.5	9.0	2.9
Holland's Institute . . . . .	(5)		(2)		(7)	(2.6)		(6.7)		(3.2)
Boys . . . . .	6	18	10	6	40	0.7	3.5	5.0	4.6	2.4
Girls . . . . .	9	14	10	9	42	1.0	2.1	3.7	5.4	2.1
Boys and girls . . . . .	15	32	20	15	82	0.90	2.69	4.26	5.07	2.27

The formation of a bend, which is changed into a more or less pronounced fold by the convexity here normally present, and which extends from the short process in the posterior half of the membrane backward and downward or ends at the posterior upper periphery, is generally regarded as an obvious pathognomonic symptom of depression of the drumhead. Its diagnostic significance is clearly marked in the above tabular statement. The posterior fold likewise comes under observation in not a small percentage of persons with normal hearing (3.62 per cent.), but its frequency rises uniformly with increasing hardness of hearing both in all the three schools and in the two sexes, and so largely that in the last column it amounts on the average to 20.61 per cent., or more than the fifth part of the children with the greatest impairment of hearing.

A greater stereoscopic prominence of the short process and the manubrium mallei is likewise included, and justly so, among the characteristic symptoms of depression of the drumhead. In accordance therewith are also the numerical relations in table *b*, which in general show a great increase toward the last column. But a comparison of the above two tables shows that the latter symptom, which indeed was only noted where it was present in a pronounced form, stands in frequency far behind the posterior fold, proportionately.

There has been left out of consideration in the tabulation another symptom which, when very pronounced, is characteristic of depression, viz., the more horizontal position of the manubrium mallei, which manifests itself in a greater foreshortening, and which authors place in the foreground among the characteristic symptoms. As we are dealing here only with differences in degree, and as it is quite impossible to draw the limit sharply between the normal and the pathological condition, I had to abstain from the start from following this symptom statistically [which is much to be regretted.—H. K.].

The condition of the reflexes was considered especially indicative for the diagnosis of local atrophic depression or of a collapse affecting the entire drumhead; and the term

atrophy was applied to all those cases in which there appeared, for instance, reflexes of concavity in the *posterior* half, and furthermore a more or less complete circle of reflexes round about in the intermediary zone, or still farther towards the periphery. Inasmuch as circumscribed atrophies and cicatrices cannot always be strictly differentiated from each other, it is possible that many a case has been included under *d* which, perhaps, had better been considered as a simple local atrophy.

*c.—Atrophy of the Drumhead.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1669	1189	470	296	3614	100	100	100	100	100
Common school . .	7	8	8	5	28	0.6	1.1	2.7	2.4	1.2
Protestant school .	4	9	4	4	21	0.8	1.9	2.3	4.5	1.6
Holland's Institute	(—)		(1)		(1)	(—)		(3.3)		(0.5)
Boys . . . . .	2	6	6	3	17	0.2	1.2	3.0	2.3	1.0
Girls . . . . .	9	11	6	6	32	1.0	1.6	2.2	3.6	1.6
Boys and girls . .	11	17	12	9	49	0.66	1.43	2.55	3.04	1.36

*d.—Cicatrix in the Drumhead.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	10	16	14	10	50	0.9	2.2	4.8	4.8	2.2
Protestant school .	1	9	5	5	20	0.2	1.9	2.8	5.6	1.6
Holland's Institute	(2)		(1)		(3)	(1.0)		(3.3)		(1.4)
Boys . . . . .	7	9	7	4	27	0.9	1.8	3.5	3.1	1.6
Girls . . . . .	4	16	12	11	43	0.5	2.4	4.4	6.6	2.2
Boys and girls . .	11	25	19	15	70	0.66	2.10	4.04	5.07	1.

## PERFORATION OF THE DRUMHEAD.

*a.—With Otorrhœa.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	—	—	2	25	27	—	—	0.7	12.1	1.2
Protestant school .	—	1	1	6	8	—	0.2	0.6	6.7	0.6
Holland's Institute	—	—	—	—	—	—	—	—	—	—
Boys . . . . .	—	—	1	14	15	—	—	0.5	10.8	0.9
Girls . . . . .	—	1	2	17	20	—	0.2	0.7	10.2	1.0
Boys and girls . .	—	1	3	31	35	—	0.08	0.64	10.37	0.97

The term cicatrix was applied to those darker spots which were surrounded by an at least in part sharp, more pronouncedly opacified, or even calcified border, or which were found sharply circumscribed in a drumhead exhibiting intense opacities over larger surfaces, and partly also were clearly depressed.

Atrophies and cicatrices, in proportion to their frequency generally, could also be pretty often demonstrated in persons with normal hearing, both in nearly the same percentage of 0.66. Both show a nearly equal gradual increase in the numbers in successively greater degrees of hardness of hearing; only we find the cicatrices more frequent (in 5.07 per cent.) in the highest degrees of hardness of hearing than atrophy (in 3.04 per cent.). They exhibit, therefore, a similar relation as the calcifications compared with the simple opacities, although this relation is not as clearly marked as in the latter case.

Perforation of the drumhead with still persisting otorrhœa is the first division in which normal hearing is no longer found at all, and in which, besides, the greatest increase can be demonstrated in the numbers towards the zero point of the hearing distance. Both circumstances, as compared

*b.—Without Otorrhœa.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school .	5	6	7	11	29	0.4	0.8	2.4	5.3	1.2
Protestant school .	—	1	2	3	6	—	0.2	1.1	3.4	0.5
Holland's Institute	(—)		(1)		(1)	(—)		(3.3)		(0.5)
Boys . . . . .	3	4	6	7	20	0.4	0.8	3.0	5.4	1.3
Girls . . . . .	2	3	3	7	15	0.2	0.4	1.1	4.2	0.8
Boys and girls . .	5	7	9	14	35	0.30	0.59	1.91	4.73	0.97

with the other anomalies of the drumhead discussed thus far, find their explanation in the fact that, where purulent otitis media is still active, a whole series of factors concur in curtailing the function; among these the chief part is played probably by thickening of the mucosa at the sound-conducting apparatus, infiltration, and inflammatory loosening of the articulations and the membranes of the fenestræ; on the other hand, in older processes, by condensations of the mucosa on points important for the conduction, calcifications, abnormal fixations, and solutions of continuity, aside from partial or total filling of the drum cavity and the auditory canal with secretion.

A smaller rise, though still greater than in all preceding anomalies, is found in otorrhœas that have run their course, with persisting perforation, at least if we take cognizance of the highest degree of hardness of hearing. But even in this division there are five auditory organs which could fully understand whispered speech at more than sixteen metres in spite of the perforation present.

In all the anomalies of the drumhead hitherto discussed, I have purposely in every case specially emphasized the number of auditory organs with normal hearing despite the visible alterations, although this fact is well known to every



observer. I have done so, in the first place, because I had at my disposal unusually large rooms for testing with whispered speech ; secondly, because these observations are of importance not only for our clinical estimation and our therapeutical manipulations in anomalies of the drumhead, but are also capable of giving us physiologically valuable information about the mechanism of the sound-conducting apparatus.

In reference to the first point, we learn in connection with the manifold alterations of the reflex anomalies of form which are characteristic of depression of the drumhead, that by themselves they prove of little importance even when the entire drumhead has become atrophic. That they nevertheless possess a high value for our estimation of the single case is evident from the fact that even in auditory organs with normal function which presented symptoms of that nature, there were frequently reported *former* hardness of hearing, earache, tinnitus, or discharge, or else on examination there was found on the *other* side impaired hearing or otorrhœa still present. Depressions of the drumhead gain importance for the hearing distance only when they occur as symptoms of a *persistent* occlusion of the tubes, that is, an existing difference of air pressure between the cavities of the middle ear and the auditory canal ; in other words, when, through excess of pressure, though minimal, of the external atmosphere on the outer surface of the drumhead, there is a disturbance of the exceedingly unstable equilibrium of the conducting apparatus. This equilibrium is an *a priori* postulate for its normal function, and is necessary for a normal conduction.

The greatest reduction of the hearing distance which may be caused through simple, persistent occlusion of the tube without secondary, functionally important alterations, and which may be at once changed into normal-hearing distance by simple equalization of air pressure, is by my clinical experience shown to be the hearing distance of 10 *cm.* for whispered speech—a distance which is found with uncommon frequency, especially in the first examination of the patients in question, that is to say, a reduction

to about the two hundredth part of the normal hearing distance. Where the latter is sunk still lower in tubal occlusion, normal hearing is as a rule no longer regained, or at least the hearing rises but slowly.

The slight weighting of the drumhead and thickening of its substance which it undergoes by deposits of lime and other elements does not demonstrably impair the hearing, particularly not—probably—when the periphery of the drumhead and immediate surroundings of the manubrium mallei are exempt, as is the rule especially with calcifications.

With reference to our therapeutics, these observations teach that no reliable prospect of material increase of function is furnished on the one hand by artificial destruction of atrophic portions in order to obtain more resistant tissue in their place, and on the other hand by excision of intermediary calcifications. This fact has been pointed out before by Schwartze<sup>1</sup> in connection with a case belonging under this head.

I know no better way for the physiological study of the sound-conducting apparatus in the living than the successive exclusion of all those parts of it about the functional importance of which we seek information. The statements given above show us, in this respect at least, how perfectly the apparatus is able to functionate despite the weighting of the drumhead with deposits, and despite the interruption of a large portion by radial and circular fibres such as are demonstrated with atrophies, cicatrices, and perforations.

With reference to the spontaneous loss and the operative removal of other single links of the chain of conduction, a large series of clinical observations is to be found in the literature. It would be a meritorious task to collect and sift them.

A more detailed report might here be subjoined of the five cases of dry perforation with approximately normal hearing distance.

CASE 1.—Girl, aged ten years. Hearing distance right and left 18 metres for whispered speech. *Right*, for the watch 45 cm. The right drumhead shows in the umbo a round perforation the

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<sup>1</sup> *Arch. f. Ohrenheilk.*, Bd. i., p. 142.

size of a lentil, which is bordered toward the front by the normal reflex framing the anterior margin of the perforation. Politzer's experiment makes a dry sound of perforation. *Left*, examination interfered with by cerumen; sound of perforation cannot be produced.

CASE 2.—Boy, aged ten years. Hearing distance on both sides 17 metres for whispered speech. *Right*, normal reflex punctiform; sulcus reflex present. Opacity of the anterior periphery; in the anterior upper quadrant a streak of opacity running from the manubrium mallei vertically downward. *Left*, normal reflex absent; sulcus reflex present; calcification as the continuation of a posterior fold. Perforation in the anterior lower quadrant. Dry sound of perforation during Politzer's experiment.

CASE 3.—Boy, aged ten years. Hearing distance for whispered speech, right 17, left 15 metres. *Right*, dry perforation, occupying one fourth in the anterior half. Older and more recent extravasations of blood in the drumhead. *Left*, dry perforation, the same size as on the right, in the anterior half. Politzer's experiment fails on account of awkwardness.

CASE 4.—Boy, aged nine years. Hearing distance for whispered speech right 17, left 18 metres. *Right*, sulcus reflex present; calcification in the anterior upper quadrant; large perforation in the anterior lower quadrant. Dry sound of perforation. *Left*, normal reflex absent; sulcus reflex present.

CASE 5.—Boy, aged seven years. Hearing distance for whispered speech, right 18, left 17 metres. *Right*, normal reflex triangular; sulcus reflex present; indication of posterior streak of opacity. *Left*, examination partly hindered by cerumen. Considerable defect of the drumhead. Politzer's experiment makes a dry sound of perforation.

The following case of extensive calcification and cicatrization deserves special mention on account of its good hearing distance.

Boy, aged eleven years. Hearing distance for whispered speech: right, twenty; left, nineteen metres. *Right*, the triangular reflex quite diffuse; the posterior upper portion of the drumhead forms a triangle reflecting *in toto*. *Left*, normal reflex absent. In the region of the umbo, a round, transparent cicatrix the size of a pea. The whole anterior half, with the exception of a narrow border in the periphery and along the anterior limit of the manubrium

mallei, is calcified ; the anterior half of the former perforation is limited by the calcification. A second calcification, corresponding to the transverse section of a lentil, is found in the posterior upper quadrant. Sulcus reflex present on both sides.

In one instance, in a girl aged nine years, a cicatrix was found in the posterior upper quadrant, through which the incudo-stapedial joint appeared in relief ; nevertheless, the hearing distance for whispered speech was eighteen metres.

Some *malformations*, likewise, came under observation.

In a boy aged nine years, *left* congenital defect of the external meatus and rudimentary auricle, of which only a projection the thickness of the little finger was present. *Right*, the hearing distance for whispered speech was eight metres. The tuning-fork is heard through the air with uncertainty, probably not at all on the left side ; from the vertex it sounds into the right ear.

Once I observed in a girl aged seven years a congenital fistula of the ear on the left side.

In two instances, boys respectively seven and eight years old, once on the right, once on the left side, I noted a remarkable malformation of the auricle which I have otherwise seen several times. In place of the regular concavity of the concha there is a very prominent vertical ridge completely filling the concavity, so that the concha here has lost its significance as sound-collector. Still the hearing distance of both organs was twenty metres for whispered speech.

In three cases, *congenital clefts of the palate* were discovered as causes of the ear affection.

The first case, a boy aged seven years, in whom the fissure extended to a large part of the hard palate, showed characteristically depressed atrophic drumheads. The hearing distance for whispered speech was : right, ten ; left, thirty centimetres.

The second case, a boy aged eight years, showed on examination symptoms of depression of the drumhead only on the left side. The hearing distance was : right, fifteen ; left, twelve metres. The boy had been repeatedly under my treatment for tubal catarrhs.

The third case, a Latin scholar aged fifteen years, who some years ago had had bilateral otorrhœa after scarlatina, shows on both sides symptoms of depression and calcification ; on the left,

adhesion of the incudo-stapedial joint to a cicatrix. Hearing distance: right, fifteen; left, five metres. In the last-mentioned two boys the fissure affected only the soft palate.

One *affection of the auditory canal* deserves brief mention on account of its *total absence*, apparently, in childhood, viz., *true exostoses and hyperostoses of the osseous meatus*.

In the three years comprised in my last clinical report, special entry was made of all exostoses and hyperostoses which came under observation; I could demonstrate their occurrence in twenty-one persons, ten times bilaterally and eleven times unilaterally. Two of the unilateral patients had suffered for years from chronic suppuration of the middle ear, with total destruction of the drumhead; in one case there were, besides, proliferations in the drum-cavity. In both cases the exostosis showed an uneven surface, with irregular epidermal covering. One occurred in an adult aged thirty, the other in a boy aged fourteen years. This form, which represents merely an ossification of the granulation tissue, and which has been described by others and myself, should not be confounded with true exostoses, which are distinguished by their smooth, spherical surface, their generally uniform, pale, thin covering of cutis, and their frequently symmetrical position on both sides.

The latter form I have seen exclusively in adults, and rather more frequently than previous authorities, if we exclude artificially deformed skulls, viz., in 0.5 per cent. of all patients and in 0.6 per cent. of adults. It was interesting to me to be able to demonstrate that among the 1918 school-children examined they were not once present. The reports on exostoses in the literature refer likewise exclusively to adults, as far as I am able to judge.

Finally it should be stated that foreign bodies were four times present in the auditory canal; twice the *Blatta orientalis*, once a fly, and once a flea adhering to the drumhead. The hearing distance in the four cases was within the normal limits.

The following table gives us information about the twenty-seven children in whom nasal speech was present and records the hearing distance of their fifty-four auditory organs.

NASAL SPEECH.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	—	6	9	13	28	—	0.8	3.1	6.3	1.2
Protestant school . . . . .	3	2	8	13	26	0.6	0.4	4.5	14.6	2.0
Holland's Institute . . . . .	(1)		(5)		(6)	(0.5)		(1.67)		(2.7)
Boys . . . . .	1	4	11	12	28	0.1	0.8	5.5	9.2	1.7
Girls . . . . .	2	4	6	14	26	0.2	0.6	2.2	8.4	1.3
Boys and girls . . . . .	3	8	17	26	54	0.18	0.67	3.62	8.78	1.49

Wilhelm Meyer, in his paper on adenoid vegetations in the naso-pharyngeal cavity,<sup>1</sup> which illuminates the subject in all directions, has also reported on extensive investigations in schools, made with a view to ascertain their frequency. Among 2,000 school-children in Copenhagen, 20, or 1 per cent., had the "dead pronunciation" so sharply characterized by him, and in a London school, of 700 children, 13, or 1.8 per cent. Digital examination proved that this was based throughout on adenoid vegetations in the naso-pharyngeal space. The close causal connection of ear affections with these proliferations has likewise been statistically ascertained by Meyer, he having found, among the 175 observations of adenoid vegetations then reported, 130 cases of ear disease.

In the above table only those cases were recorded in which the occlusion of the nose was permanent. In some of the children examined, who were proper subjects of poli-clinical treatment, the adenoid vegetations could be demonstrated rhinoscopically and removed by operation.

As regards the frequency of permanent nasal speech, the table shows that our interior country is no way behind the coast lands, it having been present in my examinations

<sup>1</sup> *Arch. f. Ohrenheilk.*, Bd. viii., p. 241.

altogether in 1.49 per cent. Although adenoid vegetations were not present in all these cases, but here and there perhaps chronic catarrhal intumescences, especially hypertrophy of the posterior end of the inferior turbinated bone as the basis of the obstruction; still we are justified, according to our clinical experience, in ascribing, at least in the great majority of cases, the presence of dead pronunciation and the characteristic mimic expression to vegetations in the naso-pharyngeal space. Besides, these different causes are at any rate of nearly equally unfavorable effect for the function of the ear. Their injurious influence on the ear expresses itself most sharply in the percentages of the above table. Normal hearing distance among children with permanent occlusion of the nose does not form the rule, but rather a rare exception; for of the fifty-four auditory organs here to be considered, only three heard normally, all the rest more or less poorly, and the increase of the numbers in the higher degrees of hardness of hearing is here much greater than we have found with the various symptoms of depression of the drumhead. Not less than 8.78 per cent. of all hearing below 4 metres had at the same time nasal speech; even among those hearing at 4-8 metres the number is still pretty large (3.62 per cent.). These high figures permit, perhaps, of the simple explanation that occlusion of the tubes, which can be demonstrated in the great majority of these cases, besides isolated suppuration of the middle ear and its residues, is here much more persistent than in the cases not complicated with complete impermeability of the naso-pharyngeal space, in which latter there remains frequently only the depression of the drumhead as the residuary symptom, while the tube has regained its patulousness some shorter or longer time previous.

#### FORMER EAR AFFECTIONS.

The following tables rest on the historical data furnished by the parents and guardians, which, of course, we must not expect to be complete, but be satisfied with what is attainable, giving us, as they do, valuable information.

# Examinations of the Auditory Organ of School-Children. 269

## Former Discharge.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	55	58	50	64	227	4.9	8.1	17.1	30.9	9.7
Protestant school . . . . .	9	25	25	32	91	1.7	5.3	14.1	36.0	7.1
Holland's Institute . . . . .	(7)			(6)	(13)	(3.6)		(20.0)		(5.9)
Boys . . . . .	38	34	34	42	148	4.7	6.7	17.1	32.3	9.0
Girls . . . . .	26	49	41	54	170	3.1	7.2	15.1	32.5	8.6
Boys and girls . . . . .	64	83	75	96	318	3.86	6.98	15.96	32.43	8.80

The statements as to preceding suppurations are pre-eminently apt to awaken our fullest attention; in the first place, because at this age they are more reliable than in the case of adults, in whom the lapse of time for accurate recollection is far too great, and the relatives, who usually have a better memory for past diseases of their wards than the latter themselves, are often no longer among the living; in the second place, because of the remarkable statistical results yielded by the following table.

The regularity with which the percentages rise, in the several schools as well as in the two sexes, with increasing impairment of hearing, was, to me, a very notable and quite unexpected fact. It is just this last table which gives us the best proof of the suitability of the classification according to hearing-quotas chosen.

Weil (*l. c.*) likewise states in regard to his examination of schools that a large number of children in Stuttgart had suffered, according to the history, from otorrhœa in the past: "Thus, for instance, in the Eberhard school, of the 1,105 children, besides the 26 affected with suppuration, 60 stated that they had formerly had otorrhœa. . . . The *suppuration*, therefore, had *ceased spontaneously* in by far the majority of cases!" What influence the preceding



suppurative processes had exercised on the *function* of the ear escaped Weil's observation, because, in his tables, he did not bring the existing and antecedent disturbances into relation with the grade of the hearing distance.

The importance of former suppurative processes for the subsequent hearing power becomes most clearly marked when we represent the series of percentages, gained from the total number of children in the above table, graphically, as has been done in the adjoining curve (Fig. 3), in which the

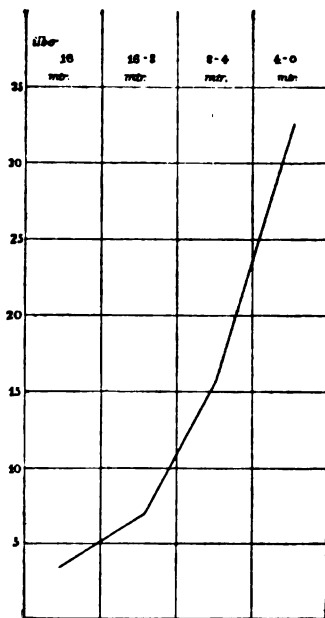


Fig. 3.

ordinals are formed from the numbers of persons with normal and defective hearing of various degrees, who had been formerly affected with suppuration. It shows clearly enough how rapidly the figures here rise towards the zero point of the hearing distance. While among those with normal acuteness of hearing there are only 3.86 per cent. with former otorrhœa, the latter is stated to have been present in 32.43 per cent. among those hearing between 4-0 metres, or nearly in *one third* among those having the highest degree of impairment of hearing.

In a large number of the children absolutely nothing could be demonstrated on the drumhead of the antecedent perforation, and merely the functional disturbance had remained as the residue of the long-past purulent inflammation. The patho-anatomical alterations which have remained in these cases might very probably be considered as analogous to those which we suppose in the so-called processes of sclerosis, and the temptation is great to conclude from the above statistical results that, in a large number of cases exhibiting little or no alterations on the drumhead, but being well characterized as affections of the middle ear by the test for osteo-tympanic conduction, especially by the aid of Weber's and Rinne's experiments, would fall at least etiologically more correctly under the diagnosis of residues of otitis media purulenta with closed perforation than under the diagnosis of otitis media catarrhalis.

Of the other antecedent ear diseases—former defective hearing, tinnitus, and earache—of which tabular statements were made, the latter two are of some interest.

As regards the presence of *subjective noises*, not much is learned on the whole from the children directly, and in the tables certainly only the higher degrees are recorded, about which the children had spontaneously spoken to their relatives. They are reported :

Among those hearing above 16 metres in 2.2 per cent.						
"	"	"	at	16-8	"	2.6
"	"	"	"	8-4	"	5.8
"	"	"	"	4-0	"	5.8
"	all the children				"	3.1

Accordingly they seem to be more frequent in childhood than is usually assumed from clinical experience.

The former *earache* reported may give us an approximate idea in how many children acute inflammatory processes had been present in the ear. Here, of course, we cannot exclude pure otalgia, which is not so rare in children in connection with dental caries. Earache was reported :

Among those hearing above 16 metres in 4.3 per cent.						
"	"	"	at	16-8	"	8.3
"	"	"	"	8-4	"	8.9
"	"	"	"	4-0	"	11.6
And in the total number of children				"	6.7	"

Finally, the statements in reference to antecedent *defective hearing* give us at least an approximate standard how great a power of observation we should presuppose in the generality of the relatives to whom the questions were directed.

I have omitted to make inquiry about antecedent *symptoms of vertigo*, because, in the absence of more detailed explanation, the relatives would have reported too many things not belonging under this head—a fact with which we become sufficiently familiar in daily practice.

#### GENERAL DISEASES OF ETIOLOGICAL IMPORTANCE.

Greater interest again attaches to the acute infectious diseases, in connection with which we frequently meet with complications involving the auditory organ. Weil, too, in a school with 1,105 children, has devoted attention to this causal connection. Among the children who had had scarlatina, measles, diphtheria, or several of these diseases at the same time, there were 4.1 per cent. with posterior fold and 2.5 per cent. with suppuration; among the children who had remained free from the infectious diseases, 2.2 per cent. with posterior fold, and 2 per cent. with suppuration. The former, therefore, presented 1.1 per cent. less tubal affections and 0.5 per cent. more suppuration. Of the 626 who had had infantile diseases, 30.5 per cent. had defective hearing distance; of the 479 free from infantile diseases, 33.8 per cent. —in other words, a preponderance of 3.3 per cent. of defective hearing among those who had not suffered from infectious diseases—a result which causes Weil himself to doubt its availability.

My statistical results respecting the influence of the acute infectious diseases on the hearing power appear from the accompanying tables.

In these tables we obtain, in the first place, as I believe, not unimportant information as to the relative frequency in general of the acute infectious diseases here considered. As the figures in this respect, gained incidentally in my investigations, are also of a more general epidemiological interest, I place them here again in juxtaposition.

# Examinations of the Auditory Organ of School-Children. 273

## a.—Scarlatina.<sup>1</sup>

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	240	159	67	58	524	21.5	20.2	22.9	28.0	22.5
Protestant school . . . . .	120	134	50	30	334	22.0	28.4	28.2	33.7	26.1
Holland's Institute . . . . .	(64)		(8)		(72)	(33.3)		(26.7)		(32.4)
Boys . . . . .	166	126	43	37	372	20.5	24.8	21.6	28.5	22.6
Girls . . . . .	194	167	74	51	486	22.8	24.6	27.3	30.7	24.7
Boys and girls . . . . .	360	293	117	88	858	21.70	24.64	24.89	29.73	23.74

## b.—Morbilli.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	555	375	165	105	1200	49.8	49.7	56.3	50.7	51.5
Protestant school . . . . .	308	253	91	45	697	54.7	53.7	51.4	50.6	54.4
Holland's Institute . . . . .	(108)		(22)		(130)	(56.3)		(73.3)		(58.6)
Boys . . . . .	401	262	93	61	817	49.6	51.5	46.7	46.9	49.6
Girls . . . . .	462	366	163	89	1080	54.3	53.8	60.0	53.6	54.9
Boys and girls . . . . .	863	628	256	150	1897	51.02	52.82	54.74	50.68	52.49

## c.—Rubeola.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . . . . .	254	177	56	39	526	22.8	24.7	19.1	18.8	22.6
Protestant school . . . . .	86	78	30	28	222	15.8	16.6	16.9	31.5	17.3
Holland's Institute . . . . .	(41)		(3)		(44)	(21.4)		(10.0)		(19.8)
Boys . . . . .	147	103	34	26	310	18.1	20.2	17.1	20.0	18.8
Girls . . . . .	193	152	52	41	438	22.7	22.4	19.2	24.7	22.3
Boys and girls . . . . .	340	255	86	67	748	20.49	21.45	18.30	22.64	20.70

<sup>1</sup> The entry in this and the following tables was likewise made according to the single auditory organs which had to be columnized with reference to their normal or reduced hearing distance, and not according to the individuals. The absolute numbers, therefore, give double the numbers of those affected with scarlatina, etc.; the percentages, however, give the correct proportions.

*d.—Diphtheria.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	235	166	65	62	528	21.0	23.1	22.2	30.0	22.6
Protestant school .	131	110	31	20	292	24.0	23.4	17.5	22.5	22.8
Holland's Institute	(53)			(5)	(58)	(27.6)			(16.7)	(26.1)
Boys . . . . .	167	119	31	41	358	20.7	23.4	15.6	31.5	21.8
Girls . . . . .	199	157	65	41	462	23.4	23.1	24.0	24.7	23.5
Boys and girls . .	366	276	96	82	820	22.06	23.21	20.42	27.70	22.69

*e.—Meningitis.*

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	23	17	5	3	48	2.1	2.4	1.7	1.4	2.1
Protestant school .	7	6	1	—	14	1.3	1.3	0.6	—	1.1
Holland's Institute	(5)			(1)	(6)	(2.6)			(3.3)	(2.7)
Boys . . . . .	24	14	—	—	38	3.0	2.8	—	—	2.3
Girls . . . . .	6	9	6	3	24	0.7	1.3	2.2	1.8	1.2
Boys and girls . .	30	23	6	3	62	1.81	1.93	1.28	1.01	1.72

Among 1,807 children—823 boys and 984 girls—of from 6 to 13 years old (Holland's Institute was left out of consideration in the summary), the acute infectious diseases of childhood were represented by the following percentages:

Scarlatina,	23.74 %	of the total number, viz.,	boys	22.6 %	girls	24.7 %
Morbilli,	52.49 %	"	"	"	"	49.6 %
Rubeola,	20.70 %	"	"	"	"	18.8 %
Diphtheria,	22.69 %	"	"	"	"	21.8 %
Meningitis,	1.72 %	"	"	"	"	2.3 %

The numbers in Holland's Institute were usually somewhat larger, possibly because the relatives of the pupils mostly belonged to the better classes, and therefore supplied more accurate statements. The rather greater frequency of scarlatina is probably traceable to a recently preceding local epidemic, which had attacked several of the pupils.

Our illustrious medical statistician, the Royal Councillor, Dr. Friedrich Majer, who for twenty-five years has published the general reports of the Health Board in the kingdom of Bavaria, shortly before his death in the midst of his restless activity, expressed himself thus, by letter, in reply to my inquiry as to the relative morbidity of the acute infectious diseases in infantile age: "As regards the average percentage of children to the thirteenth year of life who are *attacked* by scarlatina, measles, diphtheria, and meningitis, I must state that for such a calculation we lack, in the first place, all reliable data, because the number of patients in general, and the number of those attacked by special diseases in particular, is entirely unknown; if for no other reason, because only a certain part of all diseases comes under medical treatment. We must restrict ourselves, therefore, to the number of *deaths*, etc."

We may, therefore, at all events, attach a certain importance to the above percentages of morbidity, although they are based only on the statements of the relatives and on a comparatively small material, as bearing some relation to the true figures of morbidity. With the figures of *mortality* given in the statistics, however, they can be compared at most with reference to age and sex. The *relative* frequency of attacks of scarlatina, measles, rubeola, and diphtheria admits of no comparison with the figures of mortality, because the fatality of these different diseases is very variable. In regard to the age at which the several diseases occurred, the statements of the relatives were in the main inexact or entirely absent, so that the sex alone is left to us for comparison.

According to Majer's statistical tables, there have died since 1876:

		Of 100,000 inhabitants.			Of 1,000 deaths from all causes.			
		1876-80	1881	1882	1876-80	1881	1882	
Of scarlatina .	{	Boys .	35	56	55	10	17.5	17.4
		Girls .	30	48	52	10	17	18.7
Of measles . .	{	Boys .	22	17	28	6.7	5.4	8.9
		Girls .	22	16	28	7.5	5.8	10.2
Of croup and diphtheria . .	{	Boys .	117	145	131	35	45	42
		Girls .	106	135	119	37	48	43

In the time above stated, which chiefly concerns us for the children examined, there have died of the three infectious diseases among every 100,000 inhabitants rather less girls than boys, although the number *affected*, according to my above results, is throughout a few per cent. higher among the girls than among the boys. We obtain a better harmony between the above mortality figures with my morbidity figures, if the former are calculated on the basis of the total mortality figures in the years in question, as has been done in Majer's second series.

With reference to cerebro-spinal meningitis, Majer wrote me that in 1883 the whole number of deaths from this disease was 495—viz., 328 male and 167 female. The relative morbidity found by me for this disease in the two sexes, though based on too small figures, agrees well with the latter numbers.

As regards the demonstration of a causal connection of ear affections with the various infectious diseases here considered, Weil could not arrive at a positive result, because he did not put his questions separately for the several general diseases, which is absolutely necessary in view of their different influence on the ear. Thus, for instance, in my last triennial report,<sup>1</sup> among 3,787 ear patients, I could trace 185 affections of auditory organs in 121 individuals to scarlatina, but only 15 to faucial diphtheria, and 18 to measles. Therefore, the latter two infectious diseases together had not implicated the fifth part the number of auditory organs that scarlatina had done. Burckhardt-Merian,<sup>2</sup> among 1,950

<sup>1</sup> *L. c.*

<sup>2</sup> Ueber den Scharlach in seinen Beziehungen zum Gehörorgan. *Sammlung klin. Vorträge von Volkmann*, No. 182.

ear patients, found 85 (4.35 per cent.) cases which had occurred in the course of scarlatina. Bürkner<sup>1</sup> and a number of authors enumerated by him obtained still greater percentages, up to seven per cent.

Possibly the influence of the infectious diseases on the auditory organ, in the mode of investigation followed both by Weil and by myself, is hidden in part by the fact that the less resistant children have succumbed to the fundamental disease. It could readily be imagined that this fate would befall mainly such children as have previously suffered from affections of the naso-pharyngeal space and consecutively of the ear, and accordingly were specially disposed to an extension of the diphtheritic process to these spaces—a fact particularly emphasized by Guye at the last International Otological Congress at Basle. In a part of the cases it is even the grave implication of the ear which, sooner or later after the general disease has run its course, leads to a fatal termination, whereby, of course, the number of those who become hard of hearing after acute infectious diseases must be greatly curtailed.

In spite of all this, in the historical results of school investigations, the influence of a part of the acute infectious diseases on the number of ear affections finds a pretty clear expression if we employ the representation by hearing-quotas chosen above.

As could be expected, this becomes most manifest in the table of *scarlatinal* diseases. We find, at least in the total number of children, a regular rise of the percentages with increasing impairment of hearing—a fact which suffers but few exception in the various schools and sexes. Of those with normal hearing, on the whole only 21.70 per cent. had had scarlatina, but among those hearing at 4-0 metres, 29.73 per cent.

Also among the children formerly affected with *diphtheria*, some influence on the ear, though not with the same distinctness, is recognizable, at least as regards the successive increase. Among those with normal hearing, we find 22.06 per cent.; among those with the worst hearing, 27.70 per

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<sup>1</sup> L. c.



cent., who had been formerly affected with diphtheria. To be sure, in utilizing the latter number, we must not overlook that in this instance the statements of the relatives were somewhat lacking in accuracy, many a case perhaps having been counted as true diphtheria which was merely a complication of scarlatina.

The results obtained with *measles* I hold to be uncertain, for though we find an increase in moderate degrees of hardness of hearing, there is again a slight decrease, even as compared with the normal, among the higher degrees of defective hearing.

The results obtained with *rubeola* I hold to be worthless, in the first place on account of the small differences in numbers, and in the second place because this infectious disease can be differentiated with the greatest difficulty from the others. Thus I was struck by the fact that in some districts and at some time it was diagnosed with extraordinary frequency, while otherwise it was reported much more rarely.

It was to be expected that not many ear diseases would be found among those formerly affected with *meningitis*; for the cases in which this disease is complicated with affection of the ear are to be sought, as a rule, not in the schools, but in deaf-mute institutions.

#### TRAUMA AND HEREDITY.

*Trauma* was given as the cause of auditory disturbances altogether only in seven organs of hearing.

Of special interest, finally, are the statistical results as to the part played by *heredity* in ear diseases, whose relative frequency, as shown by Bürkner, has been found so different by various authors—by Moos in not less than thirty-seven per cent., by Bürkner himself only in six per cent. My own statistical investigations, made in the general report on the ear patients treated in 1881–83, have furnished me pretty large numbers, viz., for otitis media simplex chronica, without symptoms of depression on the drumhead, 27.3 per cent.; for forms of defective hearing that could not be accurately localized, 36.4 per cent.; for nervous hardness of

hearing and deaf-mutism, each 22.2 per cent.; aside from other forms of disease with smaller percentages.

Let us see, in view of these figures, what is the relation of normally hearing persons, in whose families members with defective hearing are found. As in my above-mentioned report, the consideration included only the direct ascendants as far as the grandparents, and brothers and sisters. Defective hearing, due to purulent processes among the relatives, was excluded from the enumeration. Still I would not omit to state that otorrhœa among the relatives was reported comparatively often by persons with defective hearing. In my practice, too, I have been struck by the fact how often a larger series of brothers and sisters is suffering from purulent otitis media, or the same affection was formerly present in the parents.

The school-children showed the following proportions of heredity :

HEREDITY.

Hearing distance.	Absolute numbers.					Percentages.				
	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.	Above 16 Met.	16-8 Met.	8-4 Met.	4-0 Met.	Total.
Number examined in the two public schools . . . .	1659	1189	470	296	3614	100	100	100	100	100
Common school . .	100	62	27	31	220	9.0	8.6	9.2	15.0	9.4
Protestant school .	66	49	29	14	158	12.1	10.4	16.4	15.7	12.3
Holland's Institute.	(38)		(10)		(48)	(19.8)		(33.3)		(21.6)
Boys . . . . .	83	58	25	19	185	10.3	11.4	12.6	14.6	11.2
Girls . . . . .	83	53	31	26	193	9.8	7.8	11.4	15.7	9.8
Boys and girls.	166	111	56	45	378	10.00	9.34	11.91	15.20	10.46

The table teaches, in the first place, that even among the persons with normal hearing a pretty large number, on the average ten per cent., shows hereditary affections ; this number probably is too small rather than too large, as appears also from the statements in Holland's Institute with 21.6 per cent., which may be looked upon as on the whole more accurate.

The increase of heredity with augmenting hardness of hearing is not very conspicuous, at least as regards the regular rise of the figures with growing hardness of hearing. However, in the highest degrees of hardness of hearing at least, the percentages are more than one and a half times as great as among the normal hearing, and therefore some influence of hereditary factors is unmistakable. Perhaps here too, as in the exanthematic affections, the number examined is too small to furnish positive information. Besides, it should be emphasized that the diseases which my clinico-statistical results show to be chiefly influenced by heredity are comparatively rare in childhood and develop usually at a more advanced age.

FREQUENCY OF THE SEVERAL FORMS OF DISEASE, COL-  
LATED ACCORDING TO AGE AND SEX, AND  
THEIR CURABILITY.

So far as the forms of the fundamental disease could be ascertained from the state of the drumhead, which was alone recorded, they are given in tables XX. and XXI. (pp. 281, 282).

Of the several classified ages, the number examined is too small to justify its representation *in percentages*. Also as to the frequency of unilateral and bilateral occurrence of the several forms of disease, we obtain much more accurate information from more extensive series of clinical observations, such as are found in otological reports. Therefore, in this place the percentages of the several diseases relative to each other and those of the two sexes are alone calculated.

If we collate the percentages of the diseases with reference to their *curability*, we find :

*A.—Forms Completely and Partially Amenable to Treatment.*

1. Plugs of cerumen probably occluding the ear canal	4.3 per cent.
2. Tubal catarrh	27.8 "
3. Tubal catarrh with atrophic drumhead	2.2 "
4. Acute and subacute catarrh of the middle ear	2.2 "
5. Acute and chronic suppuration of the middle ear	5.2 "
Total	41.7 per cent.

TABLE XX.

The unilateral and bilateral diseases of the ear, found in the three schools examined, collated according to the age of the persons affected.

Age.																						
	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.	Unilateral.	Bilateral.



*B.—Forms not at all or but Slightly Amenable to Treatment.*

1. Opacity of calcification of the drumhead without depression,	18.0 per cent.
2. Residues of middle-ear suppuration with persisting perforation,	3.9 "
3. Residues of middle-ear suppuration with closed perforation,	6.3 "
4. Negative state of the drumhead . . . . .	29.8 "
5. Congenital occlusion of the ear canal and rudimentary concha . . . . .	0.2 "
Total . . . . .	58.2 per cent.

*Therefore, of the children found in the schools with ear disease, according to the state of the drumhead disclosed, 41.7 per cent. offered a certain prospect of more or less complete cure if subjected to appropriate treatment.*

HYGIENIC REMARKS.

In regard to *suppuration of the middle ear*, which we find represented by 5.2 per cent. among the several diseases, I should like to emphasize here especially, that it would be not alone to the interest of the patients if their attention were called, perhaps by the school authorities, to the importance of this affection for the function of the ear, and furthermore for health and life in general, but also that such course would be desirable with reference to the other children attending school.

Among the total number of auditory organs examined, we have found 0.97 per cent. of active suppuration of the middle ear, and another 0.97 per cent. of temporarily quiescent suppuration with persistent perforation, which latter tend to fresh relapses of the suppuration with every additional injurious influence. Besides, it is not improbable that, in a part of the cases which were inaccessible to examination from the presence of accumulated masses in the depth of the ear canal, the obstruction was due, not to cerumen, but to crusts of inspissated pus. In the schools of Stuttgart, Weil demonstrated a still larger number of otorrhœas, namely, boys, 1.9 per cent. and girls 2.3 per cent.

Therefore, according to the results of Weil's and my own examinations, we shall not err if we assume that about in every class in schools there is at least *one* pupil suffering from suppuration of the middle ear, and, if left to itself, from temporary or permanent *fetid* otorrhœa. Such a continual

source of, at best, disgusting products of decomposition should not leave us indifferent in a place of which we are justified in making the highest hygienic demands.

I would like to show, by but a single instance, of what importance a day-by-day freshly secreting purulent and sanious patch of one person, such as is formed by a chronic purulent otitis media left untreated, may become to the rest of the pupils. My former assistant, Dr. Nathan, reports a case of otitis media purulenta chronica with polypoid proliferations, out of my practice,<sup>1</sup> which occurred in a boy aged nine years. The otorrhœa had existed for five years, and of late had become very abundant, so that, according to the mother's statement, the purulent, very offensive secretion usually flowed down to the shoulder during the school hours, although cleaned three times a day. (How unbearable sleeping-rooms can be rendered by the odor of otorrhoics is sufficiently proved by the complaints of the relatives.) In this last case, however, repeated microscopic examination showed that the secretion almost constantly contained Koch's *tubercle bacilli*, although the lung yielded nothing to physical examination.

I therefore consider it one of the objects of school hygiene *to exclude persons affected with otorrhœa from school so long until a rational antiseptic treatment has at least removed all fetor and, if at all possible, the discharge itself.*

#### INFLUENCE OF THE HEARING POWER ON THE MENTAL DEVELOPMENT.

A part of the mental pabulum which on an average becomes the property of children with senses unimpaired, must, of course, be lost to a greater or less extent to persons with defective hearing of various degrees. However, in this instance a completely normal hearing power forms only one among a great many factors which in their totality form the sum of the mental potency of the individual. For it is indubitable that in many cases the absence of stimulus caused by a moderate degree of defective hearing may be

<sup>1</sup> *Deutsches Archiv f. klin. Medicin*, Bd. xxxv., Heft v., p. 491, and "Arbeiten aus dem medicinisch-klinischen Institute v. Ziemssen u. Bauer," Bd. i., 2 Hälfte, p. 593.

compensated and even overbalanced by assiduous care of the relatives and teachers with such children, by appropriate literature, frequent intercourse with older children, etc., apart from the varying original capacity. Still we are *a priori* justified in assuming that, if not in the individual, yet in the examination of a large number of children, a but partial defect of this special sense, which is of importance at least in ordinary instruction, will find expression somehow in the mental development of the affected children, provided we can apply a uniform measure to them all. Such a measure, though but incidental, is furnished in schools by the rate of progress noted by the teachers in all the subjects of instruction. As I finished my examinations in Common School II. A in the month of August when the pupils were rated at the school, I placed in the following table (p. 287) the general rates of progress in relation to the grade of their hearing distance.

Among the 1,289 rated pupils of the common school, there had been found 296 who on either one or both sides heard whispered speech only at 8 metres and less; among these were 60 who heard it on both sides at 4 metres and less, and, finally, 33 who heard it on both sides at 2 metres and less. Now every single class was calculated separately in the following manner: Of each of the last-mentioned groups of hearing power, all the rates of progress were added, and from the sum was calculated the mean average place belonging to the single group of pupils with defective hearing. This average place was compared with the average place of the total number of pupils in the class in question, which is simply expressed by halving the latter number. In order to make all the classes comparable with each other, it was necessary, too, to render the number of class pupils equal to each other, which was taken at 100, so that the mean average place for the whole school is expressed by the number 50. With reference to this number, the average places were calculated which belonged to the above three groups with defective hearing.

In this way I obtained the following results of the rate of progression for the three groups with diminished hearing. The average rate of progress was:



Among those hearing on one or both sides at 8 metres and less . . . . .	54.09	instead of 50
Among those hearing on both sides at 4 metres and less . . . . .	64.36	" " 50
And among those hearing on both sides at 2 metres and less . . . . .	67.70	" " 50

These numbers, though gained from a comparatively small amount of material, prove distinctly that there was not alone some influence on the rate of progress, but that a successive increase of this influence can be demonstrated, corresponding to the degree of the hearing defect present.

In order to appreciate the importance of these figures fully, we must bear in mind that the degree of the hearing defect ascertained should not, in the majority of the children examined, be looked upon as a permanent and altogether unalterable condition, but that it is subject to great variation, and that, therefore, the limitation in following the instruction is not continuous, because, especially, a large number of pupils suffering from tubal catarrh, accumulated cerumen, etc., now and then will be enabled to hear again almost or perfectly normally. This intermittence and remittance of defective hearing is the main reason why relatives and teachers do not believe the children to be hard of hearing, but merely inattentive; therefore, the teachers particularly cannot be too often impressed with this condition. Despite the change in the hearing distance, the influence of the hearing expresses itself in the table even in the first group with defective hearing, the greater part of whom showed only so slight a defect as to hardly be taken into consideration in ordinary intercourse, and to remain unknown to the majority of the patients and their relatives.

*Hence, I believe that in the accompanying table is furnished the first statistical demonstration that also the mental development of the individual suffers a limitation corresponding to the degree that his hearing power is diminished.*

TABLE XXII.

## COMMON SCHOOL II.A.

Influence of the Hearing Power on the Rate of Progress.

	Total number of rated pupils.		Mean average rate of progress ap- pertaining to the number of pupils.		a. Pupils hearing on one or both sides at less than 8 metres.		b. Pupils hearing on both sides at less than 4 metres.		c. Pupils hearing on both sides at less than 2 metres.		Among 100 pupils in each class, those with defective hearing would oc- cupy the following average places.		
	Number.	Mean rate of progress.	Number.	Mean rate of progress.	Number.	Mean rate of progress.	Number.	Mean rate of progress.	Number.	Mean rate of progress.	a. Hearing on one or both sides below 8 metres.	b. Hearing on both sides be- low 4 metres.	c. Hearing on both sides be- low 2 metres.
Boys' class Ia . . . . .	58	29	10	36.1	4	32.0	2	29.5	62.2	55.6	50.9		
" " Ib . . . . .	63	31.5	18	42.8	6	40.5	4	51.3	67.5	78.6	81.4		
" " Ic . . . . .	62	31	5	22.8	1	30.0	1	30.0	36.8	48.4	48.4		
Girls' " Ia . . . . .	61	30.5	17	30.6	5	37.0	2	40.5	50.2	60.7	66.4		
" " Ib . . . . .	57	28.5	9	31.3	4	33.8	1	52.0	54.9	59.3	91.2		
Boys' " IIa . . . . .	63	31.5	8	41.8	3	42.7	3	42.7	66.3	67.8	67.8		
" " IIb . . . . .	63	31.5	12	35.5					56.3				
Girls' " IIa . . . . .	57	28.5	14	23.2					40.7				
" " IIb . . . . .	61	30.5	15	23.8	1	50.0	1	50.0	37.4	82	82		
" " IIc . . . . .	56	28	16	30.0	4	40.5	2	35.0	53.6	72.3	62.5		
Boys' " IIIa . . . . .	59	29.5	11	28.4	1	47.0			48.1	79.7			
" " IIIb . . . . .	58	29	14	37.9	4	49.3	3	55.3	65.3	85.0	95.3		
Girls' " IIIa . . . . .	55	27.5	17	32.6	3	25.0	1	50.0	59.3	45.5	90.9		
" " IIIb . . . . .	56	28	16	31.7	1	48.0	1	48.0	56.6	85.7	85.7		
Boys' " IVa . . . . .	61	30.5	11	36.5	2	41.5	2	41.5	59.8	68.0	68.0		
" " IVb . . . . .	62	31	11	38.2	3	22.3	2	9.0	61.6	36.0	14.5		
Girls' " IVa . . . . .	51	25.5	16	27.8	3	31.7	2	22.3	54.5	62.2	47.6		
" " IVb . . . . .	61	30.5	12	35.8	6	36.7	3	38.7	58.7	60.2	63.4		
" " V . . . . .	55	27.5	20	30.5	3	27			55.5	49.1			
" " VIa . . . . .	51	25.5	15	18.4	1	34			36.1	66.7			
" " VIb . . . . .	49	24.5	14	27.8	5	29.4	3	32.0	56.7	60.0	65.3		
Boys' " VII . . . . .	33	16.5	6	14.5					43.9				
Girls' " VII . . . . .	37	18.5	9	23.1					62.4				
Sum and average place of the various groups with defective hearing, calculated per 100 pupils, respectively, in the several classes . . . . .	1289		296		60		33		54.09	64.36	67.70	instead of 50	

## REVIEW.

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**The Organ of Hearing of the Vertebrated Animals. Morphologico-Histological Studies.** By GUSTAF RETZIUS, M.D., formerly Professor of Histology in the Carolini Medico-Chirurgical Institute at Stockholm. Vol. II.—“The Organ of Hearing of Reptiles, Birds, and Mammals.” Stockholm, 1884. For sale by Samson & Walli. Reviewed by S. Moos, in Heidelberg.

“With the present volume of this work I have reached the limit of the task that I set for myself to learn more fully the form and structure of the organ of hearing of the different classes of vertebrated animals, from the lowest fishes up to man.”

With these words the author begins the Introduction to the second volume of this work, the first volume of which, solving the same problem of the fishes and amphibia, was published several years ago.

In the following pages we shall endeavor to show how he has grasped and completed his self-imposed giant task in the volume before us. But in view of the great extent and the importance of this work, we are in doubt that we shall be able to accomplish this. If, therefore, this communication should exceed the usual length of a book review, the reader may find the reason for this in the grand plan of the whole work, and in the conscientious elaboration of the most minute details of the several parts—two fundamental qualities, which almost alone are capable of enlightening us on the comparative anatomical and histological relations of an organ, the complicated structure of which, although it

has already often occupied the best scientific workers of several generations, shows still, notwithstanding the great advances made, so many obscure points.

The author has not undertaken to describe in this work the bony capsule surrounding the membranous auditory organ of reptiles, birds, and mammals, or to give an exhaustive anatomico-histological account of the middle-ear of man. In view of Mr. Hasse's publications on the bony capsule of reptiles and birds, and the numerous descriptions given by other distinguished investigators of that of mammals, including man, it seemed no longer necessary to do this. It is probable, however, that Retzius, at some future time, will work up the middle ear of man.

Of the extent and importance of the work before us, the reader of these pages can form some idea when he learns that 400 large quarto pages are taken up by the text, accompanying which are 39 plates, containing more than 500 illustrations. Seven plates with 91 figures are devoted to the human membranous labyrinth. The illustrations are all, without exception, accompanied by a separate explanatory text. The illustrations themselves are drawn in a masterly manner by Retzius himself, and are engraved by a number of eminent artists whose names are given in the Introduction. They are all, from the beginning to the end, a truly æsthetic treat to the eye.

But our science does not deal in æsthetic pleasures, but in facts. Let us therefore examine a little more closely the contents of the work.

The organ of hearing of reptiles is treated by Retzius in four chapters: Chelonians, Ophidians, Saurians, and Crocodiles; that of birds in three: Natatores, Cursores, Incessores; that of mammals, including man, in five: Rodentia, Pecora, Belluæ, Carnivora, Man. Each of the twelve chapters, in which altogether the membranous labyrinth of thirty-nine species is described, contains an historical introduction, giving a concise, yet complete, account of the labors of other investigators. The historical part is followed by the anatomical description and the history of development according to his own researches, based

upon which disputable and doubtful points are critically examined by the author, who, when the necessity arises, maintains his own standpoint with an agreeable modesty.

I shall omit numerous details given in the description of the membranous organ of hearing of reptiles, birds, and mammals. For reasons which the readers of these ARCHIVES will readily understand, I shall limit my examination to the chapters on the membranous auditory organ of mammals, and especially of man. In many of the works on the labyrinth which have heretofore appeared, excellent as they are, the human labyrinth is either dealt with aphoristically or is not mentioned at all. But in the work before us this is so fully described and illustrated by drawings, that the book will for all time be a trustworthy guide for all who occupy themselves with the examination of the normal or pathologically altered labyrinth.

The historical review of the auditory organ of mammals and man begins with the discovery of the membranous labyrinth by Scarpa, and as it would seem also by Comparetti; but as the review refers chiefly to the membranous organ of hearing with the ductus cochlearis, only the period beginning with the discovery of Corti is considered at length. All the works on the labyrinth that have appeared during the period intervening between the publication of Corti's famous discovery in 1851, and the publication of the author's own biological researches in 1882, are mentioned in chronological order, and as this arrangement of the works is strictly carried out, we meet the names of many authors, such as Koelliker, Hensen, Boettcher, Hasse, Waldeyer, several times in the list.

The reviews of the writings which were published during these three decennaries are as thorough as they are complete. Any one who desires to increase his positive knowledge of this subject, or wishes to get information as to the present state of mooted points in the literature of the labyrinth, will find in this historical resumé all that is worth knowing, and thus save the time that would be consumed in consulting numerous books. We thus see that Schiller's utterance concerning Kant, "When kings build, the cart-

ers are kept busy," does not apply here. In the supplement the author takes up the latest investigations concerning the lymph-channels of the inner ear, to our knowledge of which the author jointly with his colleague Key, and Boettcher, Schwalbe, Hasse, and others, have contributed so much. After this follows the special histology, but "since it was impossible to obtain sufficient and good material for the examination of the inner ear of representatives of all the orders of mammalia, I have selected from the available animals the rabbit, ox, hog, cat, and man as types for the demonstration of the organ in question. Of these animals, I have described and made drawings of the form of the membranous auditory organ. The finer histological relations are demonstrated in the rabbit, cat, and man."

We have already emphasized the impossibility of doing justice to the author with regard to his comparative anatomical labors in this review of his extensive work, and for that reason shall limit our examination to the chapters dealing with the human labyrinth.

#### THE ORGAN OF HEARING OF MAN.

(Plates 33-39.)

The real extent of the perilymphatic space became known only when Reissner discovered the existence of a spiral channel, which was not in communication with the scala vestibuli, and Hensen discovered that it was connected with the sacculus, and shut off from the vestibular space. Rüdinger first showed that the membranous semicircular canals are in contact with the osseous walls, and to Reichert, Henle, and Odenius we are indebted for a correct conception of the position of the membranous organ of hearing. The keystone of our knowledge of the relations of the endolymphatic and perilymphatic spaces to each other, and to the adjacent parts, was laid by Boettcher's discovery of the true or membranous aquæduct. vestibuli (ductus endolymphaticus), and its connection on the one hand with the utriculus and sacculus, and on the other with the almost forgotten sac of Cotugno in the dura mater. "A new series of experimental injections, made carefully by Retzius

through the windows of the labyrinth in embryos and adults, have demonstrated that a free communication exists between the perilymphatic space of the cochlea (*scala vestibuli*) and the subarachnoidal spaces of the brain and spinal cord, through the ductus perilymphaticus of the aquæductus cochlea. When in these experiments the injected fluid escaped in the subdural space, it was found to be due to the bursting of the arachnoid. Notwithstanding the important labors of Weber-Liel, the unquestioned existence of the aquæductus cochlea as a perilymphatic channel to the serous spaces of the brain has not heretofore been acknowledged." To prevent misconception, the author calls the large perilymphatic space behind the fenestra ovalis the *cisterna perilymphatica vestibuli*, instead of the sinus (Odenius), and further on gives of this, as well as of the whole perilymphatic space, and especially of the topographical changes in its dimensions, a clear and minute description. The topography of the *scalæ*, the aquæductus cochlea and the fenestra ovalis, and their structure in the embryo and in the adult, are described in a like manner.

The thin periosteum, which everywhere firmly and closely adheres to the bone, forms the boundary, and at the same time, through its fibres and bands of connective tissue, containing numerous loops of blood-vessels, serves as a means of fixation. The free surface of the periosteum and trabeculæ is lined by a continuous layer of nucleated endothelial cells.

The description of the perilymphatic space is followed by the demonstration of the membranous organ of hearing itself.

Method of preparation:  $\frac{1}{4}$  to  $\frac{3}{4}$ -per-cent. osmic acid solution. Careful removal of bone and cartilage till the membranous organ with the nerve ramification is exposed. In embryos and the new-born this can often be done successfully. To reach the posterior surface of the utriculus and the sacculus is very difficult. With a strong scalpel, time, and patience, even the hard, bony substance of the adult auditory organ may be scraped away. As soon as a new portion of cavity of the capsule is opened, the prepa-

ration is returned to the osmic acid solution for from a quarter to three quarters of an hour, and in this manner the work is continued. Further manipulation of the preparation under water, by the aid of a simple microscope.

The author, in common with other writers, distinguishes in the membranous organ of man, a *pars superior* from a *pars inferior*. To the latter belong the *sacculus* with the *ductus* and *saccus endolymphaticus* and the *cochlea*, which is formed out of the enormously developed *pars basilaris* and the stunted *lagena*; the former includes the *utricle* with its appendages, etc. Only six places of nerve termination are described: three for the *cristæ* of the *ampullæ*, two for the *macula* of both of the sacs, and one for the *papilla acustica basilaris*.

The description of the course and the division of the *nervus acusticus* is noteworthy in this, that the existence in man and in other mammals of the so-called *ramulus neglectus* (discovered by Reichert and confirmed by Henle and others), which is said to proceed from the *nervus cochlearis* to the partition separating the two sacs in the vestibule, is positively denied by the author, as has also been done by Middendorp.

In describing the *utricle proprius* the author speaks of a *sinus superior* and a *sinus posterior*. The first, the so-called "semicircular commissure," proceeds from the *utricle* to the point where the anterior and the posterior semicircular canals meet at an angle of 35-40°. The *sinus posterior* is the "connecting tube" between the lower end of the *utricle* and the posterior *ampulla*.

Next follows a description of the *recessus* and the *macula acustica recessus utriculi*, the partition wall between the two vestibular sacs at the lower wall of the *recessus*, which Odenius has already minutely described of man. The walls of the two sacs do not coalesce, but can be separated from each other. On the wall of the *sacculus* there is no ramification of nerves belonging to it; the Reichert-Henle's branch of the cochlear nerve does not exist. The whole peculiarity here, as in other mammals, consists simply in the local attachment of the wall of the *sacculus* to that of the *recessus utriculi*.



The canalis utrico-sacculus, discovered by Boettcher, proceeds from a point of constriction in the lower inner wall of the utriculus. This tube lies very closely to the inner, lower circumference of the utriculus, and at last empties in the ductus endolymphaticus sacculi.

The closing paragraph of this chapter gives a synopsis of the position and the general form of the recessus utriculi.

Next follows an exposition of the ampullæ, and their semicircular canals. The author calls the horizontal ampulla and its semicircular canal the ampulla anterior, the upper or saggital the ampulla externa, and the frontal the ampulla posterior. The form, the direction, the roof with the raphé in the epithelium, and the floor with the transverse fold, caused by the entrance of the nerve twig belonging here (septum transversum), and the crista acustica with the planum semicirculatum are all minutely described of each ampulla, and the text is elucidated by very instructive illustrations of plane and profile views, and of vertical sections of each ampulla. For a detailed statement of the slight variations in the form of the above-enumerated structures in the different ampullæ, we must refer the reader to the original.

*Description of the Pars Inferior.*—Sacculus: As compared with the other vertebrates, it is pushed uncommonly far inward (downward) from the utriculus. Its irregular form in man (in the ox it is pear-shaped, according to Carl) admits of no comparison; it may be conceived as a much-flattened bladder, 3–3.5 mm. in length, and 2 mm. in width, with its long axis directed vertically, its short axis running from in front backward, and with a tapering part pointing downward and outward. The inner, slightly saucer-shaped wall of the sacculus is thick; the outer is thin, slightly concave (Odenius and has at its upper end a pouch which is attached to the recessus utriculi. From the outer posterior circumference of this wall the ductus endolymphaticus proceeds outward, and its lower circumference, together with the inner wall, sends forth the canalis reuniens Hensenii in a downward direction. The inner wall receives through several small bony canals, the nerve bundles of the short ramulus sacculi, whose fibres ramify in the shape of a fan on its inner surface, and

terminate in the macula acustica, situated in the lateral wall. The whole macula is concave, and upon it lies a thin disc, of the same shape, of otoliths. Corresponding to the dimensions of the macula, the membranous wall of the sacculus is thickened (Odenius); the nerve fibres mentioned pass through it and then bend over on to the surface of the macula. Beyond the margins of the macula the wall diminishes in thickness, and by bending round becomes the outer wall of the sacculus, which backward and outward rises up and gives off the ductus endolymphaticus; above it proceeds outward in the shape of an arch and forms a cap-shaped pouch, which is fastened to the under surface of the recessus utriculi—sinus utricularis sacculi (Retzius).

From the posterior circumference arises the ductus endolymphaticus (Boettcher) as a gradually-in-size-decreasing tube with a funnel-shaped mouth. This canal takes up, on the posterior side of the utriculus, where it is already much narrower, the canalis utriculo-saccularis, also discovered by Boettcher, with a cleft-shaped opening. Compared with the conditions found in other vertebrates, it would be more correct to take the view that also in man<sup>1</sup> the canalis utriculo-saccularis opens into the ductus endolymphaticus sacculi, or into the sacculus, than to assume that the ductus endolymph. results from the coalescence of two tubes, the one coming from the utriculus, the other from the sacculus.

Behind the sinus superior utric., upward and outward, the ductus endolymphaticus enters the bony canal of the aquæductus vestibuli, and continues in this to the apertura aquæductus vestibuli on the posterior surface of the petrous bone, where it expands and forms the saccus endolymphaticus, a closed sac lying between the layers of the dura mater. Beyond the macula acustica the lower end of the sacculus becomes funnel-shaped and forms the canalis reuniens Hensenii which is 1 mm. long, and 1.5 mm. broad. This canal at first runs downward and then turns outward to terminate in the ductus cochlearis, slightly inward of its vestibular end, inward from the posterior ampulla. This connecting channel—it has numerous homologues in other vertebrates—has no places of nerve terminations (Cotugno Boettcher).

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<sup>1</sup> As Carl has done in the ox.

*The Ductus M. Cochlearis*

of the scala med. autorum, the author divides into the pars basilaris, which in man as in all the higher mammals is strongly developed, and in the lagena cochlea which is present only in a rudimentary state. The pars basilaris he subdivides in a vestibular part (Reichert) and in a spiral part. The turn of the cochlea beginning at the canalis reuniens is called by Retzius, the basal turn, the second, the middle turn, and the third (lagena) the apex turn. The boundaries, as is well known, are not sharply defined. The division is artificial. On account of the varying width of the lagena pocket the length of the apex turn varies in different individuals; usually it measures only from  $\frac{3}{4}$  to  $\frac{1}{2}$  of a whole turn. The length of the whole ductus cochlearis in man is 36 mm. Next follow the description of the three walls of the ductus and a statement of the anatomical grounds for the variations in the size and form of the whole space in the several turns, this being triangular at the base, oval at the apex, and higher at the base than at the apex. These details are elucidated in a plastic manner on plate 35 by six figures of vertical sections through the cochlea of a man 25 years of age, on plate 14 by a series of transverse sections through the cochlea of the alligator, and on plate 18 by a series of vertical sections through the cochlea of the pigeon.

The author next describes the surroundings of the membranous ductus cochlearis, and once more refers to the relation of the scalæ. The two scalæ become narrower and even cleft-shaped in the direction toward the capsule, from the base to the apex, and wider in the direction toward the modiolus. The passage of the scala vestibuli into the scala tympani at the helicotrema is described in detail and illustrated by figs. 1 and 2, on plate 38. But whether an open, though very narrow staircase exists also in the true apex of the lagena, the author has been unable to determine.

OF THE DETAILS OF THE FINER HISTOLOGICAL RELATIONS  
OF THE PARS SUPERIOR AND THE SACCULUS.

We will only mention here that the author, after describing the membranous wall, states " that the papillæ or villi (Lucæ,

Voltolini, Rüdinger) of the semicircular canals are found in almost every grown individual, although in greatly varying numbers and arrangement"; "they are also found at the beginning of the ampullæ"; their significance is difficult to determine. In the new-born, Retzius has found them but once; in other animals they have never been seen. Retzius regards them as normal structures.

After describing the epithelium on the inner surface of the pars superior and of the sacculus, of the planum seminulatum and of the nerve epithelium, Retzius mentions particularly that the cells of the planum seminulatum, as well as the remaining epithelial lining of the pars superior of the human organ of hearing, contain in their protoplasm large and smaller masses of yellowish-brown pigment, which increases still more in old age.

This chapter closes with a description of the nerve epithelium of the maculæ and cristæ acusticæ in man. This shows the same structure as in the rabbit and the cat. It consists of thread-cells and hair-cells, as well as of the nerve-fibres running between them. The hair-cells are in connection with the nerve fibres, which, in their passage through the basilar layer of the membranous wall, lose their medullary sheath and enter the nerve epithelium as naked axis-cylinders. They then ascend between the thread-cells, and either proceed directly to the lower end of the hair-cells, or bend to the side, and after running in this direction for a short distance, at last end in the hair-cells. As long ago as 1871 Retzius found that the nerves are in direct connection with the hair-cells, and lately he has positively observed this connection in numerous preparations from the new-born and from adults (see plate 39, figs. 13-15 and 21). The substance of the nerve fibres forms a cup in which the hair-cell is planted, and when this falls out, only the cup remains (plate 39, fig. 14). "On the cristæ acusticæ the well-known cupula formation can be produced by the ordinary methods of preparation." With these words, which close this chapter, the author takes position, in the much-disputed question whether the cupula is something natural or artificial, with those who regard it as an artificial production, while in

former years he held the opposite opinion. Those who are especially interested in this question are advised to read the passages referring to this subject in the concluding chapter of the volume (pages 363 and 364). Based upon more recent researches, the author formulates the answer to the question of dispute as follows (*l. c.*): "In my opinion, there exists here a peculiar semifluid substance, which surrounds the hairs, and which, through the action of various reagents, coagulates more or less firmly, and often shrinks, whereby the hairs are more or less altered. At all events, Hensen is right in his objections to the formerly assumed existence of the cupula, and it is one of his many highly valued services to the histology of the organ of hearing to have shown that the cupula does not exist, but that, on the contrary, the acoustic hairs project high into the lumen of the ampullæ."

Plates 35 to 39 elucidate the description of the minute structure of the ductus cochlearis of man contained in the next chapter. Taking the middle turn as the type, the author describes the relations found here, and in connection therewith mentions the peculiarities existing in the other turns. A table giving the measurements and number of the various parts of the different turns is appended to this chapter.

*The Vestibular Wall, the Membrana Reissneri*, is a thin membrane without vessels, which in the middle turn is in the main spread out in a straight line. It consists of a layer of structureless connective tissue, which is here and there slightly striated. Its vestibular surface is lined by a single layer of endothelial cells and a few spindle-shaped cells, which sometimes contain pigment. Its tympanal surface is covered with a polygonal pavement-epithelium, which in places is elongated or spindle-shaped, contains yellow pigment granules, and is arranged in vortices. The round or grape-like prominences, which project from this surface like villi into the canal, are not of a pathological nature; they consist of peculiar, round, granular cells, with a more spherical nucleus. They are constantly found in all the turns. The outer wall of the membranous ductus cochlearis is intimately connected with the periosteum, from

which it cannot be separated. The connective-tissue foundation consists of a transparent, structureless ground-substance with numerous fine, branching, interlaced, and anastomosing connective-tissue fibres; the ground-substance contains also many protoplasmic, markedly granular cells, with off-shoots in various directions. This connective tissue, which is thickest in the ligamentum spirale, is traversed by numerous blood-vessels; it decreases in thickness, as periotum, toward the scala tympani, also in the direction of the scala vestibuli, though more gradually, and at the insertion of the membrana Reissneri it is continued in this membrane as well as in the scala tympani. This connective tissue on the outer wall of the cochlea gradually diminishes in thickness up to the apex of the cochlea. The tip of the ligament. spir. is connected with the basilar membrane, which is here inserted, and whose fibrous layer is continued in the sulcus lig. spir. Upon this connective-tissue foundation rests the epithelium of the outer wall of the membranous ductus cochlearis, as it does in other animals. Next follows a minute description of the crista lig. spirale. (Boettcher) or the process of the vas prominens (Hensen), and of the sulcus lig. spir. (Boettcher), of the stria vascularis, and of the relations of the epithelium (six figures on plate 35). At the point where the epithelium is diminished in height the boundary between it and the connective tissue is so indistinct, that it must remain an open question whether epithelium or connective tissue, or a mixture of both, is present. The author decides in favor of the latter view. "With the blood-vessels a small quantity of connective tissue extends into it." In man, as in the rabbit, we see in the stria vascularis a vascular epithelium of a markedly granular appearance, containing pigment granules.

In describing the tympanal wall the author employs the term *limbus for crista spiralis*, the radial width of which increases toward the apex, where it is as wide again as below. The *lam. spir. ossea* decreases in thickness in the same direction.

The form of its vestibular surface is convex at the base, straight in the middle turn, and concave in the apex turn.

At the place of insertion of Reissner's membrane its substance is raised in the form of a low ridge, the *crista memb. Reissneri*, which is continued in an attenuated condition into this membrane, whereby the epithelium of this membrane passes over into that of the limbus, and the vestibular endothelium of the limbus into the periosteal endothelium of the inner portion of the *lam. spir. oss.* The limbus or the *crista spir.*, the continued membranous portion of the *lam. oss.*, is composed of a striated fibrillar ground-substance, like connective tissue, and contains numerous cells, most of which are spindle-shaped; a few capillaries pass through the under part of the limbus, but they rarely reach the vicinity of the free surface. This surface shows the well-known projections, the acoustic teeth of Huschke, between the furrows of which are placed a series of small nucleated cells poor in protoplasm. These cells the author found, by using the silver method and staining the nuclei, in the new-born and in adults, as well as in the cat and the rabbit, to extend from the depth of the furrows to the free surface of the limbus, and here to spread out as a layer over the projections, the papillæ as well as the teeth; they form with their upper ends on the free surface of the limbus a level cell-mosaic of small polygonal fields (see fig. 4, *cz*, plate 38). On tearing away the *membrana tectoria* the upper ends of most of them come away with it. In embryos and in adults these cells are of cylindrical form and are not in direct connection with the limbus tissue, and this is the reason why, during maceration in water, they so easily fall out of the furrows. Next follows a minute description of the teeth; they decrease steadily in size toward the apex, so that, at the end of the *papilla basilaris*, they appear stunted. There are 7,000 of these teeth. They project over the *sulcus spir. int.* Then follows an account of the *labium vestibular.* and the *labium tympanicum.* Beneath the vestibular layer of the *labium tymp.* run the bundles of medullated nerve fibres which course toward the *habenula perforata*, where the *labium* ceases and is continued in the *membrana basilaris.* The diameter of the nerve-channels (of which there are about 4,000) is largest in the middle

turn. The basilar membrane is thinner in all the turns in man than in the rabbit and the cat. Its inner zone corresponds to the floor of the tunnel, and extends from the habenula to the outer margin of the points of attachment of the outer pillar-cells, and is the thinnest part of the membrane. The outer zone, the *zona pectinata*, extends from here to the insertion of the membrane in the *ligamentum spir.* This zone very gradually increases in thickness to its outer third, and then decreases again in the direction of the *lig. spirale*.

By staining with *rosaniline* and acetate of potassa the author has been enabled to study the character and the course of the fibres in this membrane. They are very fine, and striated in a radial direction. They run parallel, sometimes singly, sometimes in bundles, thus giving a ribbed appearance to the membrane. Each millimetre contains about 680, so that perhaps, 2,400 are present in the entire cochlea. On account of the slight thickness of the membrane, the author has, however, been unable to determine positively the location of the fibres with regard to the other layers of the membrane. The author was also unable to demonstrate the second layer of fibres which is visible in the rabbit. In radial vertical sections, both surfaces of this membrane were seen to be bounded by sharply defined, even contours. A few spindle-shaped nuclei, with their long diameter in a radial direction, were found in the middle of the membrane. The tympanal homogeneous lining layer, as well as the vestibular, is but slightly developed, both in embryos and adults. The peculiar tympanal lining layer of cells with protoplasmatic, varicose processes at both poles is, on the contrary, abundantly present in all the three turns in man. This layer of cells covers the entire tympanal surface of the basilar membrane from the *habenula perforata* to the *lig. spir.* Under the floor of the tunnel the section of the narrow *vas spirale* is seen embedded in these cells. The structure of the basilar membrane at the *ligamentum spirale* has already been described above. The length of this membrane varies in different individuals, and is often not the same on both



sides of the same individual. On an average it, as well as the papilla basilaris, measures in man 33.5 *mm*.

Of the epithelial lining of the tympanal wall of the membranous ductus cochlearis, we must distinguish the papilla acustica basilaris proper from the epithelium of the sulcus spiralis internus, and from the epithelium of the zone lying outward of the papilla, the so-called sulcus spiralis externus. The epithelial lining of the floor of the sulcus spiralis internus consists of a single layer of pavement-epithelium.

The papilla acustica basilaris, or the organ of Corti of man, represents a ribbon-shaped epithelial intumescence, which lies upon the basilar membrane throughout its entire length, and is composed of the same elements as in the cat and the rabbit. It consists exclusively of epithelial cells, or their derivatives, and nerve fibres: no connective-tissue fibres are found in it. This is followed by the well-known distinctions: two rows of Corti's pillar-cells, the inner hair-cells, the inner supporting cells, the outer hair-cells, the Deiters's cells, and the outer or Hensen's supporting cells. In man, too, the nerve fibres follow a spiral and a radial course.

The author is of the opinion that in adult man, as in the cat and the rabbit, the inner as well as the outer pillars are only parts of still existing cells—the pillar cells,—and gives of them a minute description and drawings of radial, vertical sections and of surface preparations.

The Deiters's cells also are constructed and arranged as in the cat and in the rabbit. There are four (sometimes three) rows of them. They begin at the basilar membrane with small polygonal foot-plates, in the middle of which, and nearer the inner circumference, ascends a fine, fibrillar thread. This is not connected with the basilar membrane, and in radial vertical sections appears to be situated at the inner boundary line of the cell. In the upper part of the cell is contained a globular nucleus, and still higher up the transparent contents of the cell pass into a granular mass containing pigment, and in then continued into the cylindrical upper phalangeal process. These processes ascend

obliquely through the space of Nüel, pass by two hair-cells, and are inserted in the third phalanx; the author, in common with Hensen, regards the phalanges in question as the free upper end-plates of Deiters's cells. The bright thread also terminates at the phalanx after it has passed through the granular portion of the cell-body and the phalangeal process. Since in man many hair-cells are wanting in the second, third, and fourth rows, the phalanges are placed side by side, and thus fill the places of absent cells.

Between the Deiters's cells are situated the outer hair-cells. They are of cylindrical form, and their pointed lower ends are attached to the inner, granular portion of Deiters's cells. They are, however, not organically connected with these cells, and have no processes. They pass free through Nüel's space to the round holes in the lamina reticularis, which is made up of the phalanges. These holes are filled with the upper ends of the hair-cells. The outer hair-cells perish in various reagents; their form is, however, very well preserved by osmic acid. In man the granules of the cell-contents adhere less closely together than they do in the rabbit. The upper end of these cells contains a round or oval, not sharply defined, body (Hensen). The author was unable to discover that any part of the cell was connected with a nerve fibre. "All that I could make out was that the lower pointed ends of the cells touch the upper nerve fibres of the outer spiral bundles, or are in a manner inserted into them. From the free upper-end surface, which is placed obliquely to the long axis of the cell, the hairs project free into the lumen of the membranous ductus cochlearis. Each cell possesses at least twenty hairs; they are of equal length, short above, stiff, lustrous, and of the same width up to their free ends."

Viewed from above the end-surfaces of these cells present the form of a crescent or a horse-shoe (see the drawings).

#### THE ARRANGEMENT OF THE OUTER HAIR-CELLS.<sup>1</sup>

The first turn has but three rows, but these, as a rule, are arranged in a beautiful, regularly alternating, order, which

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<sup>1</sup> Of the nine illustrations on plate 37, eight show in a very instructive manner the number and arrangement of the outer hair-cells. Only figures 1 and 2,

in the middle turn is already more or less disturbed ; here the arrangement varies, a fourth row is added. The same occurs in the apex coil, but when a fourth row is present, the second and third rows are, as a rule, deranged and incomplete. Even a fifth row is sometimes seen in the middle and the apex turns, but it is represented by only a few cells, never by a complete row. Great differences in this respect prevail in different individuals ; at all events, the fourth row is more numerous represented in man than in the rabbit or the dog, but it is not by any means a peculiarity of man, that would perhaps be of special interest from an anthropological point of view.

The number of outer hair-cells is estimated by the author at from 11,500 to 12,000.

The description of Hensen's outer supporting cells, and of the epithelial cells lining the basilar membrane outward of the papilla, the details of which we cannot give here, is followed by that of

#### THE INNER HAIR-CELLS.

They are like those in the cat and the rabbit : markedly granular, protoplasmatic cells, of elongated, irregularly cylindrical form, with the globular nucleus near the lower end. The free surface is much broadened, increased in length in a spiral direction, oval, and carries here the free glistening hairs in a straight or slightly convex line in spiral order. Each cell has at least twenty hairs, which in form and length are very similar to those on the outer hair-cells. These cells are inclined outward, and lie close to the inner pillar-cells in a spiral line ; their upper ends rest in the furrows formed by the pillar-cells. Immediately inward of this line are occasionally found supernumerary hair-cells. The lower end of these cells, which is isolated with great difficulty, is jagged, sinuate, rarely rounded off, and is surrounded by a network of fine varicose nerve fibrils. The real termination of these fibrils, the author was unable to make out. Below these cell-ends, which hang down to about

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with three rows each from the basilar and middle turn of an adult, show a regular arrangement in all the rows. In all the others the arrangement is irregular as far as the fifth row.

the middle of the height of the epithelium, lie the nuclei, described as "granules" by Boettcher and Waldeyer, surrounded by a network of nerve-fibres. According to the author, these nuclei are not nervous elements, but indifferent epithelial cells, which carry the nerve fibres embedded between them. The author was unable to isolate these cells in an unmutilated condition ; here and there he saw a single one project as a thin, granular thread-cell from the membranous wall to the surface of the epithelium. Here some of them terminate with a long, broad, flat end-plate, inward of the inner hair-cells. The cells situated still further inward are ordinary epithelial cells, which extend to the surface of the inner end of the papilla, and inward pass over into the cells of sulcus spiralis.

#### COURSE OF THE NERVE FIBRES.

After emerging from the medulla, all the fibres of the acusticus are provided with a sheath of myelin and Schwann's sheath ; outside of the axis-cylinder and the myelin sheath is found Schwann's sheath with its constrictions and nuclei (Key and Retzius<sup>1</sup>).

In the human acusticus both broad and narrow fibres are found. The myelin sheath of the latter is very varicose, Schwann's sheath follows the depressions in the myelin sheath. All nerve-cells of the acusticus are truly bipolar. Beneath the maculæ and the cristæ acusticæ the nerve-fibres give up their sheath of myelin and Schwann's sheath, to enter, as naked axis-cylinders, the epithelial layer, and to unite with the lower ends of the hair-cells. The fibres of the ramulus basilaris, on the other hand, are collected in bundles, anastomose with one another, and pass through the labium tymp. to the habenula perforata ; their course can, however, be traced clearly only in the apex winding (see fig. 8, plate 38), as in the two other windings they are packed very closely together. They are manifestly covered by the nucleated sheath of Schwann as far as the upper apertures of the canals of the habenula perforata ; the myelin sheath is given up somewhat sooner, especially in the apex turn, on

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<sup>1</sup> According to Retzius this is wrongly denied by Ranvier.

entering the canal, or even before. The naked axis-cylinders, after leaving the vestibular openings of the habenula perforata, run downward toward the scala vestibuli and outward, and separate into fine varicose fibrils, which in part bend back in a spiral direction and form the not sharply bounded, first spiral strand, situated on the inner side of the inner hair-cells; from these a few filaments ascend to the vicinity of the lower ends of the inner hair-cells, which they surround as a network; but a direct connection between them does not exist. Other fibres run in a radial direction between the inner pillar cells to the tunnel space, and on their outer side, at the foot-plate angle, bend over in a spiral direction into the second spiral or tunnel strand, which, in cross-sections, is seen to run as a sharply defined, round, or oval strand, along the entire tunnel. From this are given off, at almost regular intervals, varicose bundles of various sizes, which proceed in a radial direction through the tunnel space outward, or outward and upward, pass between the outer pillar-cells, and also in a radial direction through the so-called Nüel's space, and at the inner side of the first row of Deiters's cells enter a bundle of nerve fibres running in a spiral direction, and pursue their course with it. In man each row of Deiters's cells has, at the middle of its inner side, an outer spiral strand of fine varicose filaments running parallel with one another, which, in cross-sections, appears as a longish oval bundle, clinging close to the inner side of the bodies of Deiters's cells, and extending upward to the lower end of the outer hair-cells. The final ending of the nerve fibres has not as yet been positively ascertained.

The author describes next, the intercellular spaces, the tunnel space, and Nuel's space, which is well developed in man. Both are closed at both ends of the papilla basilaris by cells. "I never saw a direct communication between Nuel's space and the endolymphatic space through the lamina reticularis."

The membrana tectoria, or membrana Corti, is a flat, ribbon-shaped, soft, and somewhat elastic formation, which extends along the entire papilla. It is narrower in the basi-

lar winding than in the other two. It may be divided in two zones; the inner, which is very thin, is fastened to the surface of the epithelium of the limbus spiralis by a reticular cementitious substance. The inner margin of this zone lies between the angle of insertion of Reissner's membrane and the edge of the limbus vestib. The second zone of the membrana tectoria overhangs free the sulcus spir. int. and the papilla; it ascends toward the scala vestibuli in the middle and apex windings, increases in thickness in the middle, becomes thinner again toward the edge, and scarcely reaches to the outermost row of hair-cells. Occasionally there are still found in adults, especially in the apex turn on the upper plates of the outermost Deiters's cells, fragments of fibre, which are evidently the rudiments of fibres which served as points of fixation for the membrane during embryonic life. About the middle of the tympanal surface of the membrane, is found the so-called Hensen's stripe. The membrane consists throughout of extremely minute filaments, which resist the action of acetic acid; in the outer, thicker zone, they bend back toward the scala tymp., and proceed in this curved direction to the under surface of this membrane.

The description of the organ of Corti in man is followed by a statement of the number and measurement of the different parts of the labyrinth of the rabbit, the cat, and man, and this is further elucidated by a tabular synopsis. Although very interesting and worth knowing, we cannot reproduce the figures here, and must refer the readers for them to the original. The reason for the differences existing between his own figures and those given by Waldeyer and Krause, the author finds in this, that Waldeyer and Krause probably found the cells and structures in question more closely packed together than he did. Thus, for instance, the author estimates the number of outer hair-cells at from 11,500 to 12,000, Waldeyer at 18,000, and Krause at as much as 19,800.

The final chapter of the work is devoted to

## GENERAL REMARKS

referring to the form of the organ of hearing, as well as to the minute structure. The results obtained by him with regard to the form of the labyrinth, the author has utilized in a very interesting manner for the phylogenesis. Unfortunately space will not permit us to enter into particulars. Merely to give an instance, we will mention, however, that the careful study of the auditory organ of reptiles has established the fact that the phylogenetic development is accomplished through the class of reptiles, as the intermediate link between the amphibia on the one hand, and the birds and mammals on the other; also, that the intermediation between the "post-reptiles," or ancestors of the birds, and the true mammals, as regards the organ of hearing, takes place in a striking manner through the monotrema. Compare the investigations of Hyrtl and Ibsen on the form of the organ of hearing of the *Ornithorhynchus* and *Echidna*, which resembles very closely that of the crocodile and birds. Urban Pritchard's researches have, moreover, shown that in the *Ornithorhynchus* the papilla acustica has become a true organ of Corti.

In considering the second main question, the minute structure of the membranous organ of hearing, the author dwells mainly on the structure of the places of nerve terminations. For particulars with regard to this we refer to what has preceded. It is certain, according to the author, that the primary fibrils unite with the lower ends of several (2-4 or 5) hair-cells in such a way that they surround the protoplasma of the cells like a marble or as a shell, whereby a closer union is secured. Whether primary fibrils also surround the upper portion of the hair-cells before ending in their protoplasma, must remain an open question for the present. *"At all events, it is certain that the hair-cells are in direct connection with the nerve fibres. The hair-cells of the maculae and cristae acusticae must therefore be regarded as true sensory cells, and their acoustic hairs retain the importance claimed for them as sensory terminal apparatuses."*

Finally, the author gives a résumé of Corti's organ of mammals.

Up to the present, anatomical science did not possess as minute a description of the membranous labyrinth of man, as the one which the author has here given us. For this reason we have tried to give the readers of these ARCHIVES an—in many places literal—abstract from the author's description. But he who wants to have a correct conception of the whole must study, not merely read, the work itself—an arduous but highly profitable undertaking. All who do this will concur with us in the opinion that the work under consideration will remain for all time an imperishable landmark for our science; to his wreath of scientific fame the author has added a new leaf which will never fade, and by the now completed work he has raised for himself a permanent monument: Monumentum ære perennius!

With a view of placing the author's studies of the membranous organ of hearing of man within the reach of a large and more especially interested circle of readers, we may be permitted to express the wish that he may be induced to publish separately in the form of a monograph, the description of the same, with the illustrations pertaining to it, and at the same time to describe more fully than he has been able to do in the work before us, because of its length, the various methods of preparation which he has employed.

We have learned with deep regret, from the Introduction, that the author's health was seriously impaired by the arduous labors which he performed in the preparation of this work. And yet this is not at all surprising.<sup>1</sup> We indulge, however, in the hope that this regrettable episode was vanquished long ago. Nay, more; we hope that a kind fate has bestowed upon him a long life and uninterrupted good health, so that he may be permitted in the future to enrich our science in as great a measure as he has done heretofore, partly alone, partly in association with his esteemed friend and colleague, Axel Key, and that he himself may enjoy the fruits of his labors for many years to come!

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<sup>1</sup> Our readers will be astonished to learn that Retzius published almost simultaneously with the work under consideration, a richly illustrated history of civilization of Finland.





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